Dominating Ancillary Product Markets via Self-Preferencing*

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Abstract

In many two-sided markets, transactions between buyers and sellers require ancillary products, like iOS developers require electronic payment technologies, or Amazon sellers require product storage. Beyond their primary services, gatekeepers expand into ancillary product markets and practice self-preferencing—leveraging their dominance in the primary market to favor their sales in the competitive ancillary product market. Empirical evidence from a recent antitrust case suggests that regulating self-preferencing may harm buyers and sellers. Analyzing a theoretical model that incorporates the key market features, I find that when the gatekeeper finds self-preferencing profitable, sellers always benefit, while buyers can be harmed under certain conditions.

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JEL Codes: L21, L40, L51.

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1 Introduction

The development of digital technologies has granted us unprecedented access to information and remarkable convenience. Recently, the global number of internet users has reached 5 billion, representing 67 percent of the world's total population.[1] Internet users often derive value from interacting with each other and benefit from a growing user base. Such network effects enhance the appeal of dominant companies, leading to increasing reliance on gatekeeper firms. 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 approximately 1.6 million packages shipped by Amazon.[2]

In addition to their core services, gatekeeper firms have continuously expanded into ancillary product markets (see Athey and Scott Morton (2021) and Heidhues et al. (2024)). These ancillary products often complement the gatekeepers' core services in the primary market, facilitating transactions between sellers and buyers. For example, Apple provides electronic payment technologies for iOS developers to interact with mobile users, Amazon offers product storage for sellers to fulfill Amazon orders, and Google supplies multiple complementary technologies for advertisers in the digital advertising market. While gatekeepers dominate the primary markets, they often face competition in the newly developed ancillary product markets. Within such a market structure, gatekeepers often leverage their dominant positions and users' trust in the primary market to promote ancillary product sales in the adjacent market. I define this phenomenon—where a gatekeeper reduces sellers' profits if they use competing ancillary products—as self-preferencing across markets.

This phenomenon has become prevalent and gained significant attention from regulators. Since 2021, the European Commission (EC) has been investigating Google's self-favoring practices in the advertising technology (adtech) industry.[3] In 2024, the U.S. Department of Justice (DoJ) accused Google of the same self-preferencing practices.[4] Similar strategies have also been observed in Apple and Amazon. Specifically, Apple was fined €1.8 billion by the EC for prohibiting music streaming app developers from informing users about potentially cheaper subscription channels outside of Apple.[5] Additionally, Amazon was found to exhibit bias in its recommendation algorithm, the Buy Box,[6]

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

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

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

[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.

in favor of sellers who use Amazon's logistics and delivery services.[7] In Europe, self-preferencing practices are now strictly forbidden in the Digital Markets Act (see Decarolis and Li (2023b) and Peitz (2023)). In the US, a series of high-profile cases involving self-preferencing are currently ongoing.[8]

Despite heated discussions and substantial efforts by regulators, there is surprisingly little economic research on how self-preferencing in the ancillary product market affects social welfare, and even less guidance on related regulatory interventions. To investigate, I start by empirically studying a recent antitrust case against Google in the display advertising market, where publishers (apps and websites) and advertisers must rely on multiple layers of adtech to interact. The French Competition Authority (FCA) targets two adtech layers used by publishers. It points out that Google has been practicing self-preferencing across those adtech layers, leveraging its dominance in one market to favor its technology in the other.

To alleviate self-preferencing in France, Google agreed on a series of commitments with the FCA. I focus on the data-sharing commitment that requires Google to share ad auction data with competing companies. With this new data access, competing firms are expected to better understand why they lose in ad auctions and improve their adtech logarithms. To assess the impact, I collect weekly data on advertising revenue and advertiser counts for the top 50 most popular domains in each European Economic Area (EEA) country. In comparison to other EEA countries, France experienced a sharp decline in both advertiser participation and publisher ad revenue following the regulation. These results suggest that advertisers and publishers—buyers and sellers in the advertising market—can be worse off following self-preferencing regulations.

To explore the underlying mechanism, I developed a simple theoretical model that captures the key 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 primary product sold by a gatekeeper firm. Additionally, sellers must also purchase an ancillary product in an adjacent market to accomplish interactions. Although the primary product is monopolized, ancillary products are offered by both the gatekeeper and competing firms. Sellers choose and purchase the ancillary product, and their choice affects the surplus of both buyers and sellers. Moreover, inconsistencies may arise between buyers' and sellers' preferences. For instance, iOS users might prefer cheaper music subscriptions from non-Apple channels; however, due to Apple's self-preferencing, iOS developers are prohibited from informing users about alternative electronic payment channels outside of Apple.

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

[8] See https://www.bradley.com/insights/publications/2024/01/hp-facing-antitrust-class-action-alleging-unlawful-self-preferencing.

The model gives rise to several key findings. First, I show that the gatekeeper is motivated to practice self-preferencing as long as there is a high level of substitutability among ancillary products and the quality of the gatekeeper's ancillary product is not too low. The results support the observations that self-preferencing has become a popular strategy for gatekeepers. On the one hand, self-preferencing allows the gatekeeper to charge higher prices for its ancillary products and to capture a larger market share in the adjacent market. The price increase makes it more costly for sellers to complete transactions and discourages their entry into the primary market. Such reduced seller participation, on the other hand, diminishes the gatekeeper's profits from selling the primary product. When the two products are sufficiently similar, self-preferencing shifts a significant portion of sellers from competing ancillary products to the gatekeeper's ancillary product, thereby increasing the gatekeeper's profit.

Second, I find that the welfare implication of self-preferencing is complex and jointly determined by various factors, including product similarity, and the preferences of buyers and sellers regarding ancillary products. In the adjacent market, self-preferencing diminishes the profit of competing firms and discourages their entry in the long run. In the primary market, under specific conditions, both buyers and sellers can benefit from self-preferencing. Thus, regulating self-preferencing without careful design may backfire. In the basic model where the primary product is free for buyers, the gatekeeper's motivation for self-preferencing is congruent with the seller's interests in the short run. In other words, sellers are better off given that it is profitable for the gatekeeper to practice self-preferencing.

This is because self-preferencing increases the likelihood that sellers choose the gatekeeper's ancillary product. Hence, for each additional seller attracted to the market, the probability that the seller utilizes both the gatekeeper's primary and ancillary products rises, resulting in a greater profit for the gatekeeper. This dynamic encourages the gatekeeper to lower its primary product prices in exchange for increased market participation, ultimately benefiting sellers. However, the negative welfare impact may arise on the buyer side. Precisely, if buyers derive a significantly lower utility from the gatekeeper's ancillary product compared to others, self-preferencing could harm buyers even though it remains profitable for the gatekeeper. Otherwise, buyers also benefit.

Combining these findings with the recent investigation results published by the EC and DoJ, I illustrate an explanation for the data patterns observed in France. As shown in the model, given that it is profitable for Google to engage in self-preferencing, publishers (sellers) and advertisers (buyers) benefit from self-preferencing unless there is a competing firm highly preferred by advertisers. This exception is unlikely, as both the DoJ's and the EC's ongoing investigations have confirmed that Google also engages in self-preferencing from the advertiser side. This leads advertisers to dislike interacting with publishers using non-Google adtech. In such a market context, alleviating self-preferencing solely on the publisher side without addressing the advertiser side pushes publishers to non-Google technologies that advertisers dislike. Hence, the data-sharing commitment is expected to reduce the surplus of both buyers and sellers, which aligns with the observations in France.

It is natural to ask whether regulating self-preferencing is necessary, and if so, how to regulate it effectively. To investigate, I provide two counterfactual analyses. First, I examine the long-term impact of self-preferencing if no regulations were ever implemented. The analysis reveals that allowing the gatekeeper to monopolize the adjacent market over time could generate severe negative effects on both buyers and sellers. Thus, it is highly necessary to monitor and regulate self-preferencing in digital markets. Second, I discuss the potential outcomes if Google had implemented a structural divestment as proposed by the EC and DoJ. I show that if the divestment effectively eliminates Google's self-preferencing incentives on both the publisher and advertiser sides, divestment is more likely to enhance social welfare than the FCA's regulation. However, if the divestment only removes self-preferencing on the publisher side without addressing the advertiser side, it could reduce user surplus more severely than the FCA's behavioral approach.

The remainder of the paper is organized as follows. I next illustrate the paper's contribution to the literature. In Section 2, I analyze a recent antitrust case against Google, highlighting some surprising data patterns. Motivated by these empirical findings, I develop a basic model in Section 3, followed by an investigation of self-preferencing impact in Section 4. Additionally, I present two counterfactual analyses in Section 5 and discuss several extensions in Section 6, Lastly, in Section 7, I conclude.

Contribution to Literature This paper intersects with several strands of literature. First, it complements the existing literature on vertical foreclosure. As noted by Motta (2023), vertical foreclosure occurs when a digital platform sells a primary product alongside another product offered by competitors and provides the necessary inputs that competitors must use to finalize their sales. In such a context, the platform is able to foreclose rivals in adjacent markets.

Several papers analyze foreclosure in vertically integrated markets. For instance, Kang and Muir (2022) argue that such vertical foreclosure benefits consumers at the expense of producers if the platform is a monopoly in the upstream market. However, if the platform faces competition in the upstream market, it can harm both consumers and producers. De Corniere and Taylor (2014) focus on the vertical integration between a search engine and a publisher in the advertising market, demonstrating that integration can lead to recommendation bias by the search engine but may potentially benefit consumers.

The foreclosure practice is also often described as "self-preferencing" in the context of hybrid mode platforms (De Corniere and Taylor, 2019; Dendorfer, 2023). Specifically, hybrid mode platforms refer to those that not only serve as intermediaries connecting sellers with buyers but also operate as retailers selling products directly to consumers. Many studies in this strand of literature focus on the platform's bias in recommendations toward its own retail offers. For instance, Zennyo (2022) model self-preferencing as the platform always including its own offer in consumers' consideration sets, Kittaka and Sato (2022) define it as consumers checking the platform's offer before others, and Hagiu et al. (2022) conceptualize it as the platform hiding innovative sellers' products from buyers.

Such "hybrid mode" self-preferencing in existing research is different from the "cross-market" self-preferencing analyzed in this paper in several aspects. First, their tradeoffs are different. In the hybrid mode, the platform offers a mandatory input—intermediation services—that sellers must use to reach buyers. Thus, the platform's tradeoff typically involves monetization through charging sellers referral fees, or by collecting from buyers direct retail margins. The welfare implication of self-preferencing largely hinges on its influence on the referral fee (see Etro (2023a) and Kittaka et al. (2023)). For instance, Anderson and Bedre-Defolie (2022) show 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) point out 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 (2023b) shows that self-preferencing has ambiguous impacts on referral fees and thus consumer surplus, depending on its product's demand elasticity. In the recent work of Padilla et al. (2022), they also provide several well-established economic theories for a rationale of self-preferencing on hybrid mode platforms.

In the cross-market self-preferencing scenario, the gatekeeper firm no longer provides mandatory inputs for competing firms in the ancillary product markets to reach customers. Consequently, the gatekeeper cannot extract the competitors' profits through referral fees or input charges. For instance, storage warehouses do not need to pay Amazon when assisting Amazon sellers; external payment technologies do not need to pay Apple when serving iOS developers; and non-Google adtech used by publishers do not need to pay Google when interacting with advertisers using Google adtech. Hence, the tradeoffs in vertical foreclosure do not fully apply. Additionally, the double marginalization widely studied in the vertical foreclosure literature may disappear.

Besides the underlying mechanisms, the market features of the two types of self-preferencing also differ. In the hybrid mode, buyers are typically both the purchasers and users of final products. 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. Such non-negative price restrictions significantly influence market outcomes and regulations of hybrid mode self-preferencing. However, the non-negative price constraints rarely apply to sellers, who become the purchasers of ancillary products in the phenomenon of cross-market self-preferencing (see Gomes and Tirole (2018)). In the adjacent market, ancillary products are selected and purchased by sellers, but are often used by buyers. Since buyers and sellers may prioritize different features of ancillary products, their preferences can diverge. This potential inconsistency in preferences between buyers and sellers further complicates the cross-market self-preferencing phenomenon.

The paper also 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; Biglaiser et al., 2019) highlight the significance of network effects in multi-sided markets. These network effects lead users to increasingly prefer platforms with larger sizes, thereby contributing to industry concentration. Incorporating the network effects into my model, I highlight that the existence of network effects increases the gatekeeper's motivation to practice self-preferencing in ancillary product markets. Moreover, it reduces the likelihood of welfare harm to consumers.

Lastly, the paper is naturally related to studies on recommendation and user search (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; Gambato and Risco, 2024). It also connects to empirical works on Amazon. For instance, Farronato et al. (2023) and Waldfogel (2024) both point out that Amazon-branded products rank higher than observably similar products in consumer search results. Additionally, Chen and Tsai (2019) points out that products sold by Amazon receive substantially more "Frequently Bought Together" recommendations in its marketplace. In the study by Lee and Musolff (2021), it is shown that Amazon's algorithmic recommendations are highly price elastic and that consumers prefer Amazon. Consequently, this self-preferencing mechanism does not act as an entry barrier for sellers; rather, it increases consumer surplus in the short run. Similarly, Lam (2021) notes that alleviating self-preferencing may reduce welfare unless firms re-optimize prices. Moreover, Gutiérrez (2022) 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.

The paper is, to the best of my knowledge, among the first to study a specific new self-preferencing phenomenon in ancillary product markets. Complementary to my research, a recent study by Dong and Cong (2024) focuses on Amazon's self-preferencing in the shipping industry and models it as bundling. In the work of De Corniere et al. (2024), they also study Amazon's practice and frame it as tying. Specifically. they argue that the tying between Amazon's intermediation services and ancillary products diminishes the vertical differentiation among sellers, enhances competition, and benefits buyers. My paper focuses more on the adtech industry and takes a quite different angle, modeling self-preferencing as sellers experience diminished profits if they use competing ancillary products. This stems from the observation that, in many markets, the primary product is not always strictly bundled or tied to its ancillary products. In other words, sellers can typically access the gatekeeper's primary product or service even when utilizing rival ancillary products. For example, iOS developers using external payment technologies can still list on Apple's App Store, advertisers employing non-Google adtech can still interact with publishers using Google adtech, and sellers utilizing external storage services can still sell on Amazon. Through a different approach, I show that the welfare implications of self-preferencing may either benefit or harm buyers, depending on their preferences and ancillary product qualities.

2 A Recent Antitrust Case

I initiated the study by empirically analyzing a recent antitrust case against Google in the adtech industry. Nowadays, the adtech market is a vital component of the global economy, valued at $1,066.8 billion in 2023 and expected to expand to $3,528.4 billion by 2032.[9] Given the complexity of how various technologies interact in the adtech industry, I first introduce the institutional background of the display advertising market and the antitrust case. Next, I show how the display advertising market evolved after the regulatory interventions.[10]

2.1 Institutional Background

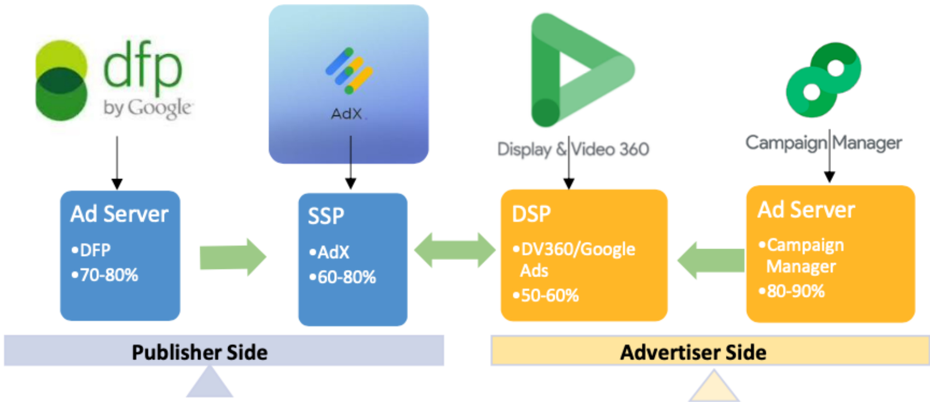
In the display advertising market, publishers, like websites and apps, constitute the supply (seller) side that offers available ad spaces, and advertisers represent the demand (buyer) side that purchases spaces to catch eyeballs. Both publishers and advertisers rely on an intricate chain of advertising technologies to accomplish interactions with each other.

In a simplified adtech stack as shown in Figure 1, ad servers work as the first technology layer for publishers. The servers assist publishers in managing ad inventory and 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

[9] See https://consent.yahoo.com/v2/collectConsent?sessionId=3_cc-session_cc2b14da-4704-475b-8a8b-79717dc1b17d and Lewis and Rao (2015).

[10] Although the actions taken in the FCA's case against Google resulted from agreements between the competition authorities and the companies, without formal remedies or interventions, I may refer to it as interventions or regulations throughout this paper.

Figure 1: A Simplified Adtech Stack



agencies purchasing ad spaces must also employ demand-side platforms (DSPs), which allow them to participate in auctions organized by SSPs or by other sources.

Each layer in 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. The server then requests bids for these impressions from the connected SSPs. The SSPs transmit these requests to the connected DSPs, which select winning ads through auctions and send the winning bids back to the SSPs. Next, the SSPs conduct an auction among all the bids from the 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 the bids received from its SSPs and notifies the selected ad to be displayed.

In the current adtech market, Google is active and dominant in almost all layers of the adtech stack. In 2023, Google's adtech business generated $31 billion in revenue, accounting for one-tenth of Alphabet's revenue.[11] As pointed out by the DoJ: "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."[12]

The company provides an ad server, "DoubleClick for Publishers (DFP)", and an SSP, "Google Ad Exchange (AdX)" for publishers. The DFP and AdX both fall under Google's re-branded "Google Ad Manager" services, but they fulfill distinct functions. In the US, Google holds an 87 % market share

[11] See https://www.nytimes.com/2024/09/09/technology/google-antitrust-ad-technology.html.
[12] See justice.gov/opa/pr/justice-department-sues-google-monopolizing-digital-advertising-technologies.

in the adtech industry.[13] In Europe, 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 60-80% of sales in the EEA, depending on the state. On the advertiser side, Google's Campaign Manager serves 80-90% of all impressions, while its DSPs, Google Ads and Display & Video 360, capture 50-60% of demand.[14]

In June 2021, the FCA fined Google €220 million for prioritizing its programmatic advertising services under the Google Ad Manager brand.[15] The penalty was a result of the FCA's investigation into the ad server and SSP markets. The FCA's investigation focuses solely on the publisher side, without considering adtechs used by advertisers. According to the FCA, Google had been engaging in reciprocal self-preferencing: it provided more advantageous terms to its SSP (AdX) compared to competing firms, including 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.

To address the anti-competitive concerns, Google reached an agreement with the FCA to gradually fulfill a series of commitments in France[16], including (i) allowing fair access to information on the auction process for third-party SSPs; (ii) preserving the full contractual freedom of third-party SSPs so that they can negotiate special conditions with publishers and are not blocked from deciding to include or exclude specific buyers; (iii) ensuring that AdX no longer uses the price of its competitors in order to optimize its bids in a way that is not reproducible by third-party SSPs; (iv) offering guarantees of technical stability, both for third-party SSPs and for publishers; and (v) making changes to existing configurations that allow publishers using third-party ad servers to access AdX on-demand in "real-time".

2.2 Data Pattern

My investigation focuses specifically on the data-sharing commitment: Google must grant rival SSPs the same access to auction data as it provides to its own SSP. To fulfill the commitment, Google introduced a new implementation of real-time integration, which grants publishers access to relevant data about ad auction outcomes. As announced by Google, competing SSPs would gain access to

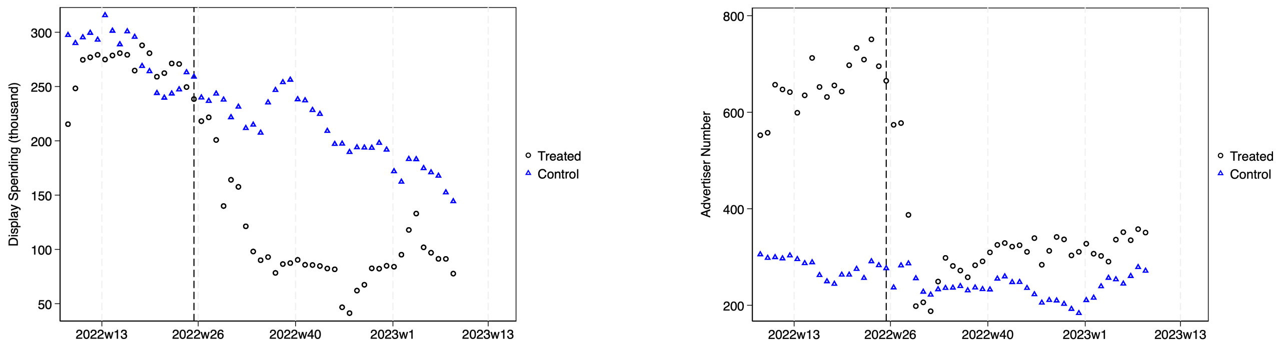
[13] See https://www.nytimes.com/2024/09/09/technology/google-antitrust-ad-technology.html.

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

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

[16] 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.

Figure 2: Display Advertising Market



(a) Publisher Revenue

(b) Number of Advertisers

more auction data by June 2022. This data-sharing commitment is expected to help non-Google companies better understand why they lose in ad auctions and improve the quality of their algorithms. When Google shares data with competing firms, its comparative advantage and self-preferencing are alleviated.

To investigate the impact of data-sharing commitment, I collect data from various sources. To start, I employ Similarweb[17], an Israeli firm specializing in web traffic and performance analysis, to identify the top 50 most popular websites in each EEA state. Based on this sampling list, I gather advertising performance data from the SEMrush platform.[18] Specifically, I record the weekly ad revenue on each domain to measure the surplus of publishers. I also track the weekly number of unique advertisers posting ads on each domain to measure the surplus of advertisers. The time frame of my sample is between February 28, 2022, and March 5, 2023.[19] 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 examine the surplus of publishers and advertisers following the regulation. Intuitively, if publishers are better off, they should derive higher ad revenue after the data-sharing commitment. Similarly, if advertisers benefit, their participation should increase accordingly. In Figure 2a, I present the weekly average advertising revenue for popular domains in France and other EEA countries. The dashed line marks June 30, 2022, the implementation deadline for Google's data-sharing commitment. I find that both France and the control group experienced declines in advertising revenue after the dashed

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

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

[19]I exclude websites belonging to the FAANG group (Alphabet, Amazon, Apple, Meta, and Microsoft), as they typically do not utilize Google Ad Manager.

line. However, the reduction in revenue was notably larger in France than that in other countries. I then plot the weekly average number of advertisers on each domain in Figure 2b. The figure shows a sharp drop in the number of advertisers in France following Google's data-sharing commitment. The decrease in advertiser participation suggests that advertisers in France are likely to be worse off after Google alleviated self-preferencing in the adtech market.

The analysis is among the first empirical evidence for self-preferencing regulation in the adtech market.[20] The data patterns are striking as they suggest that alleviating self-preferencing might not benefit either buyers or sellers in a two-sided market.

3 Basic Model

3.1 Model Setup

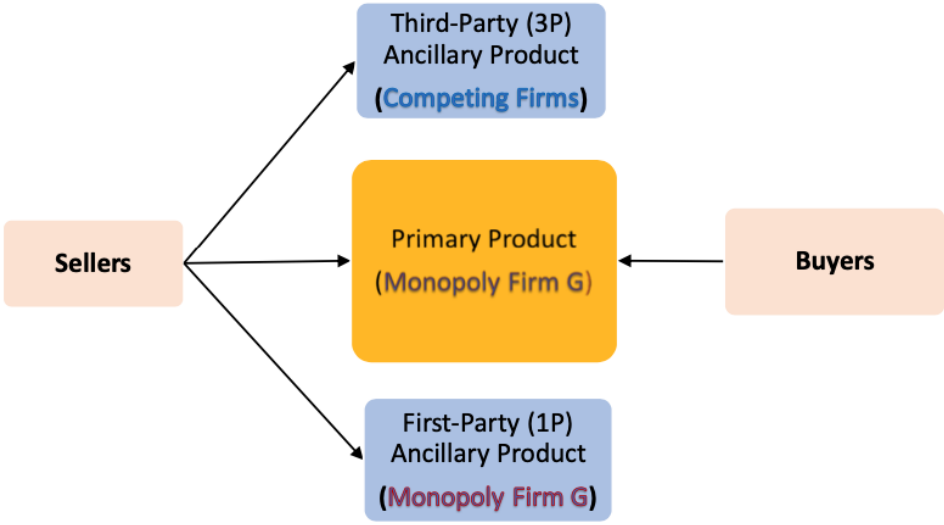
To better understand the self-preferencing phenomenon, I create a simple theoretical model that captures the key market features. There is a two-sided market where users gain value from interactions with each other. To simplify notations, I refer to one group of users as sellers (he/his) and the other as buyers (she/her). However, the model setup is general and encompasses other market types. For example, in the context of the display advertising market, the two groups transform into publishers (sellers of advertising slots) and advertisers (buyers of advertising slots).

Buyers and sellers rely on a primary product from a gatekeeper firm G to interact with each other. In addition, sellers must purchase an ancillary product in an adjacent market. As shown in Figure 3, while firm G monopolizes the primary product market, it faces competition in the adjacent market. In addition to firm G, there are also $N \geq 1$ competitive fringe firms selling similar ancillary products. These fringe firms all incur the same entry cost L and their products have no vertical differentiation.[21] Specifically, I refer to firm G's monopolized market as the primary market, its product in the adjacent market as the first-party (1P) product, and all other firms' ancillary products as third-party (3P) products. Accordingly, I categorize sellers who use the 1P ancillary product as 1P sellers and sellers who use 3P ancillary products as 3P sellers. To simplify without loss of generality, I normalize the marginal costs of the primary and ancillary products to zero throughout the analysis.[22]

A seller has two ancillary products in his consideration set: one is always the 1P product from

[20]See Decarolis and Li (2023a) for a comprehensive empirical analysis.
[21]This entry cost is not collected by firm G.
[22]The relaxation of this assumption should not affect the main conclusions in the paper.

Figure 3: Market Structure



firm G, and the other is his most preferred 3P product. Each fringe firm has an equal chance of being the seller's favorite, so the probability that any fringe firm $k \in \{1, 2, ..., N\}$ is included in the seller's consideration set equals $1/N$. A seller perceives the two products in his consideration set as both vertically and horizontally differentiated. Vertical differentiation is modeled by sellers' diverse profits when they choose different ancillary products. If sellers choose the 1P ancillary product, they expect a profit of v_G^s from joining the market. However, if sellers choose a 3P ancillary product instead, they expect a profit of $v_k^s = v_G^s - \beta_s$. The parameter β_s measures the vertical difference between the two ancillary products. Its value can be either positive, zero, or negative. If 1P sellers derive a higher profit from joining the market than 3P sellers, then $\beta_s > 0$. Otherwise, it is the opposite.

Horizontal differentiation is modeled in the Hotelling fashion. As shown in Figure 4, the two ancillary products 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 Hotelling line and incur the cost of not having one's ideal ancillary product that linearly increases in distance at rates t. Within this setup, the surplus of seller j, who has fringe firm k in his consideration set and purchases the ancillary product from firm $i \in \{G, k\}$, is given by

$$U_s(\theta_j, i) = v_i^s - p_i - m_S - t|\theta_j - l_i|,$$

where $\theta_j \in [0, 1]$ is the position of seller j, $l_i \in \{0, 1\}$ represents the location of product i, m_S is the primary product price, and p_i denotes the corresponding ancillary product price.

Although sellers are the ones who choose and pay for the ancillary products, their choice of ancillary

Figure 4: Hotelling Line

products affects the surplus of both buyers and sellers. Specifically, buyers derive a utility of $U_b = v_G^b$ if sellers choose the 1P ancillary product and $U_b = v_C^b = v_G^b - \beta_b$ if sellers choose 3P ancillary products. Buyers' 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. In summary, a buyer's total expected utility from joining the market is given by

$$U_b = \begin{cases} v_G^b, & \text{if 1P ancillary product} \\ v_G^b - \beta_b, & \text{if 3P ancillary product.} \end{cases}$$

The timeline of the game is as follows: First, firm G sets its price in the primary market. Second, fringe firms and firm G simultaneously choose the prices of ancillary products.[23] Given the product prices in the primary and adjacent markets, 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. *In the basic model, I assume:*

- ***[Postive Demand]*** *the product values satisfy $|\beta_s| < 3t$ so that both the 1P product and 3P product derive a positive demand at equilibrium; and*
- ***[Competitive Market]*** *the surplus is sufficiently large $v_G^s > (6\beta_s t + 45t^2 - \beta_s^2)/(36t)$, such that there exists competition between the 1P ancillary product and 3P ancillary products.*

Before I proceed, let me discuss the basic model setups. First, in the basic model, I take the number of firms in the adjacent market as exogenously given and focus on the short-run impact of self-preferencing. In Section 5.1, I endogenize firms' entry into the ancillary product market and discuss the long-run impact of self-preferencing. Second, the basic model abstracts away the cross-group network effects. In other words, a user's surplus—both on the buyer side and the seller side—is not

[23] The market will converge to the same equilibrium if the first two steps occur simultaneously.

influenced by the participation of the other group. Such network effects are incorporated into the model in Section 6.1, where I derive qualitatively similar conclusions to those in the basic model. Moreover, I find that the existence of positive network effects enhances the gatekeeper's motivation for self-preferencing. Third, in the basic model, I assume that the primary product is free for buyers. This assumption is inspired by the observations that many companies, such as Amazon Marketplace, Airbnb, and Apple's App Store, offer free intermediation services for buyers. The assumption is relaxed in Section 6.2, where I examine the market outcomes if firm G charges both buyers and sellers in the primary market.

Additional robustness checks are documented in the Appendix, including: allowing horizontal differentiation between the 1P and 3P ancillary products to be affected by firm entry into the adjacent market (Appendix D.1), analyzing a market where buyers' spending on 1P and 3P sellers is fixed (Appendix D.2), and modeling transactions between buyers and sellers and letting the ancillary product charge based on a per-transaction basis (Appendix D.3).

3.2 Market Equilibrium

I next solve for the subgame perfect equilibrium. I initiate the analysis by examining sellers' demands for ancillary products, as well as the demands for the primary product on both sides of the market. I then investigate firms' pricing decisions in the adjacent market, followed by an exploration of firm G's profit-maximizing pricing strategy in the primary market.

Seller Demands If firm G 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 $U_S(\bar{\theta}(k),G) = U_S(\bar{\theta}(k),k)$. Solving this equation, I derive the indifferent seller's location as follows:

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

As illustrated in Figure 4, sellers located at $\theta_j < \bar{\theta}(k)$ will purchase from firm G, while the rest will choose firm k. Given that fringe firms have an equal probability of being included in a seller's consideration set, the fraction of sellers considering firm k is n_s/N. As for firm G, it is considered by all sellers, regardless of their consideration sets. Therefore, the demands for the two ancillary products can be expressed as:

$$Q_G = \sum_{k=1}^{N} \bar{\theta}(k)\frac{n_S}{N} = \sum_{k=1}^{N} \frac{(\beta_s + p_k - p_G + t)}{2t}\frac{n_S}{N},$$
$$Q_k = \left(1 - \bar{\theta}(k)\right)\frac{n_S}{N} = (1 - \frac{\beta_s + p_k - p_G + t}{2t})\frac{n_S}{N},$$

where Q_G represents the demand for the 1P ancillary product, and Q_k denotes the demand for 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* joining the market. This corresponds to the idea that app developers may not charge subscription fees until they build a loyal user base, or sellers on Amazon may not consider their storage choice until they receive several orders. It is only after a seller joins the market and understands how the ancillary product works jointly with the primary market that he becomes aware of his preferences for ancillary products. In such a context, a seller's expected surplus from joining the market, denoted as $E[U_s]$, equals:

$$E[U_s] \;=\; \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)}(v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^{1}(v_G^s - \beta_s - p_k - t(1-x))dx\right)\frac{1}{N} - m_S.$$

As for buyers, their expected utility depends on the distribution of sellers among ancillary products and can be written as:

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

Users in both groups will join the market if 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.[24] Within this model setup, the demands for the primary product 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:

[24] I focus on the scenario where the product values v_G^b and v_G^s meet the condition $0 < n_B, n_S < 1$ at equilibrium. Otherwise, the market converges to the trivial case in which either no users enter the market or all users participate.

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

As for firm G, it earns additional profit from providing the primary product. Accordingly, its profit is expressed as:

$$\pi_G = m_S n_S + p_G \sum_{k=1}^{N} \bar{\theta}(k)\frac{n_S}{N} = m_S n_S + \sum_{k=1}^{N} p_G \frac{(\beta_s - p_G + p_k + t)n_S}{2Nt}.$$

As illustrated in the previous analysis, sellers' demand for market participation is jointly determined by all firms in the ancillary product market. To ensure that the model is tractable, I assume each firm in the ancillary product market takes the aggregate demand n_S as given and maximizes its profit simultaneously. At the symmetric equilibrium, the product prices are given by:

$$p_G = t + \frac{\beta_s}{3}, \tag{1}$$

$$p_C = t - \frac{\beta_s}{3}, \tag{2}$$

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:

$$Q_G = (\frac{1}{2} + \frac{\beta_s}{6t})n_S, \tag{3}$$

$$Q_C = (\frac{1}{2} - \frac{\beta_s}{6t})\frac{n_S}{N}, \tag{4}$$

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 $q_G = Q_G/n_S = \frac{1}{2} + \frac{\beta_s}{6t}$.

Primary Product Pricing Lastly, I analyze firm G's pricing strategy over its primary product. Given the ancillary product prices (expression 1-2) and demands (expression 3-4) at equilibrium, the explicit demands for market participation can be expressed as:

$$
\begin{aligned}
n_B &= v_G^b + \frac{\beta_b(\beta_s - 3t)}{6t}, \\
n_S &= \frac{\beta_s^2 - 18\beta_s t - 36tm_S - 45t^2 + 36tv_G^s}{36t}.
\end{aligned}
$$

Maximizing firm G's profit by solving the first-order condition, I derive the profit-maximizing price in the primary market as:

$$
m_S^* = \frac{36tv_G^s - \beta_s^2 - 30\beta_s t - 63t^2}{72t}. \tag{5}
$$

Given the equilibrium pricing strategies, the demands for the primary product are given by:

$$
n_B^* = \frac{\beta_b\beta_s + 6tv_G^b - 3\beta_b t}{6t}, \tag{6}
$$

$$
n_S^* = \frac{\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s}{24t}, \tag{7}
$$

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

I lastly calculate the equilibrium profits of firms and derive:

$$
\pi_G^* = \frac{(\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s)^2}{576t^2}, \tag{8}
$$

$$
\pi_C^* = \frac{(3t - \beta_s)^2(\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s)}{432Nt^2} - L, \tag{9}
$$

where π_C^* denotes the profit of each individual fringe firm at the symmetric equilibrium.

In summary, the market equilibrium in the basic model 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 (6) to (7), 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 firm G choose the pricing strategies listed in expression (1)-(2) and (5), leading to the profits as shown in equations (8)-(9).*

4 Equilibrium Analysis

Based on the market equilibrium, I investigate the impact of self-preferencing in Section 4.1. Then, in Section 4.2, I present recent findings published by the EC and DoJ regarding Google's self-preferencing in the adtech industry. Combining these investigation results with my model, I propose an explanation for the observed data patterns in France. All proofs are included in the Appendix.

4.1 Self-Preferencing Impact

When a gatekeeper engages in self-preferencing, sellers who opt for 3P ancillary products experience a lower surplus from entering the market. The gatekeepers can implement self-preferencing through various strategies, including reducing the interoperability of its primary product with competing ancillary products, restricting rivals' ability to improve product quality, or steering customers away from sellers using competing ancillary products.

As shown in Equations (1-2), 1P and 3P ancillary products have the same price when there is no vertical differentiation for sellers. The introduction of vertical differentiation, β_s, lowers the price of 3P ancillary products by $\beta_s/3$ while raising the 1P ancillary product price by $\beta_s/3$. If the gatekeeper firm diminishes the profits of sellers who opt for 3P ancillary products, the 1P ancillary product becomes relatively more attractive, i.e., β_s increases. Hence, in the adjacent market, the 1P ancillary product price increases, while the price of 3P ancillary products decreases.

In the primary market, firm G diminishes its product price following self-preferencing. This is because the 1P ancillary product becomes more expensive after self-preferencing, making it more costly for sellers to fulfill transactions in the market. As a consequence, sellers' entry is discouraged, resulting in a reduction in their demand for the primary product. To compensate for this negative impact, the gatekeeper firm G has to reduce its product price m_S in the primary market.

In summary, the impacts of self-preferencing on firms' pricing strategies in the primary and adjacent markets can be outlined as follows:

Property 1. *In the basic model, self-preferencing*

- *increases 1P ancillary product price p_G;*
- *decreases 3P ancillary product price p_C; and*
- *decreases the primary product price m_S.*

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

Property 2. *In the basic model, self-preferencing can either increase or decrease the demand for market participation. Specifically,*

- *if 1P sellers derive a higher surplus than 3P sellers, i.e., $\beta_s > 0$, then self-preferencing increases sellers' demand for market 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 market participation;*
- *if buyers prefer 1P sellers, i.e., $\beta_b > 0$, then self-preferencing decreases buyers' demand for market participation. Otherwise, it is the opposite.*

When the gatekeeper firm practices self-preferencing, there are two conflicting effects on seller participation. On the one hand, self-preferencing directly diminishes sellers' surplus when they opt for 3P ancillary products. On the other hand, self-preferencing motivates the gatekeeper to reduce its primary product price as shown in Property 1, simultaneously enhancing sellers' surplus. Interestingly, if 3P sellers derive higher profits than 1P sellers, i.e., $\beta_s < 0$, the negative impact of self-preferencing is always dominant on seller participation. The underlying mechanisms can be illustrated by revisiting sellers' expected surplus from joining the market:

$$
\begin{aligned}
E[U_s] &= \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}}(v_G^s - p_G - tx)dx + \int_{\bar{\theta}}^1 (v_G^s - \beta_s - p_k - tx)dx\right)\frac{1}{N} - m_S, \\
&= -m_S + \int_0^{q_G} \underbrace{(v_G^s - t - \frac{\beta_s}{3} - tx)}_{\text{sellers using 1P product}} dx + \int_0^{1-q_G} \underbrace{(v_G^s - t - \frac{2\beta_s}{3} - tx)}_{\text{sellers using 3P product}} dx. \qquad (10)
\end{aligned}
$$

When the gatekeeper practices self-preferencing, the relative quality of 3P ancillary products decreases. As shown in Equation (10), an increase in β_s has a stronger negative impact on 3P sellers than on 1P sellers. When $\beta_s < 0$, most sellers opt for 3P products. Such a large ratio of 3P sellers strengthens the overall negative effects of self-preferencing, leading to a corresponding reduction in seller participation.

If 1P sellers derive higher profits than 3P sellers, i.e., $\beta_s > 0$, the overall impact of self-preferencing on seller participation can be either positive or negative. When the transportation cost is low, the ancillary products are highly similar for sellers. In such a market, self-preferencing causes a large portion of sellers to switch from rivals to the gatekeeper. The market share increase in the adjacent market makes it more profitable for the gatekeeper firm to increase participation. Therefore, firm G has a stronger incentive to reduce its primary product charge in exchange for a higher market participation after self-preferencing.

However, when the transportation cost t is high, ancillary products are highly differentiated for sellers. In such a market, self-preferencing can only shift a few sellers from rivals to the gatekeeper. As each additional seller attracted to the market remains likely to choose competing ancillary products, firm G's motivation to increase seller participation diminishes. Consequently, the reduction in primary product price 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, I find that buyers benefit from self-preferencing when they show a growing preference for 1P sellers over 3P sellers. Otherwise, it is the opposite. As illustrated in the previous analysis, self-preferencing encourages more sellers to choose the 1P ancillary product. When buyers prefer the 1P ancillary product over 3P ancillary products, self-preferencing pushes more sellers to switch to the ancillary product that buyers prefer. Thus, buyers are better off and more inclined to enter the market following self-preferencing. Conversely, when buyers strongly favor 3P sellers over 1P sellers, self-preferencing directs more sellers toward the ancillary products that buyers dislike. As a result, buyers are discouraged from entering the market following self-preferencing.

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. Since the user surplus in both groups is increasing in their participation, we could view market participation as a measure of user surplus in each group. Keeping this in mind, the results suggest 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 or sellers. In the simple basic model, I show it is possible for both buyers and sellers to achieve a higher surplus following self-preferencing.

Lastly, I examine the gatekeeper firm's profit to shed light on self-preferencing incentives. I find that it is not always profitable for firm G to practice self-preferencing, as summarized in Property 3.

Property 3. *In the basic model, the practice of self-preferencing always reduces the profit of competing firms. However, self-preferencing can either increase or decrease firm G's profits. Specifically,*

- *if 1P sellers derive a high surplus than 3P sellers, i.e., $\beta_s > 0$, then self-preferencing increases firm G'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 firm G's profit.*

The interesting results emerge when combining Property 2 with Property 3. As illustrated in Property 4, in the basic model, the gatekeeper firm's incentive for self-preferencing is always congruent with the sellers' interests. In other words, sellers always benefit from self-preferencing when such practice is profitable for the gatekeeper. However, there can be harmful impacts on buyers if $\beta_b < 0$. In other words, buyers incur welfare loss when they prefer 3P ancillary products, while sellers strongly favor the 1P ancillary product. The findings highlight self-preferencing's potential negative impact on welfare. Furthermore, they clarifies the conditions under which it might occur.

Property 4. *In the basic model, when the gatekeeper firm finds self-preferencing profitable, the surplus of sellers always increases following self-preferencing. However, the impact of self-preferencing on buyers' surplus can be either positive or negative. Specifically,*

- *if $\beta_b > 0$, self-preferencing increases buyers' participation and their surplus;*
- *if $\beta_b < 0$, self-preferencing reduces buyers' participation and their surplus.*

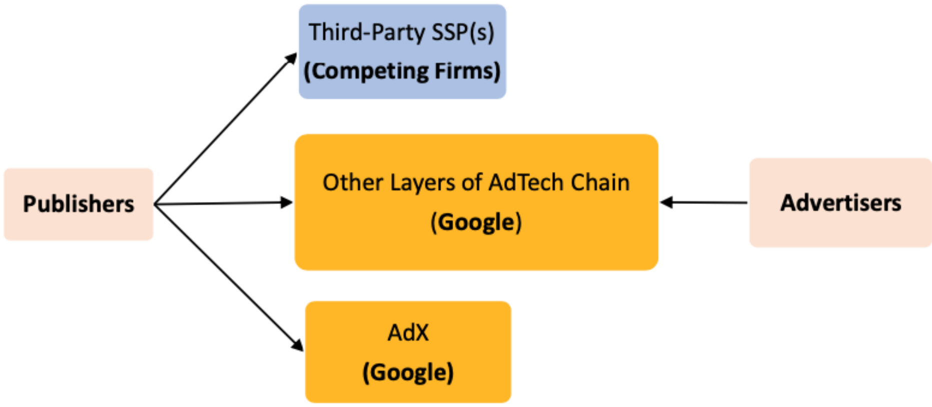
4.2 Google Adtech Case

I now apply the basic model to the Google Adtech Case. Combined with the recent investigation results by the EC and DoJ, the model illustrates a potential explanation for the data patterns shown in Section 2. Additionally, it highlights the potential determinants of self-preferencing regulation effectiveness.

To map the adtech stack and Google's data-sharing commitment to my model, I decompose the whole adtech stack into two complementary markets. As shown in Figure 5, the first market encompasses all layers of the adtech stack except for SSP. This market is dominated by Google and is employed by both publishers and advertisers for interaction. The second market is the SSP market, where

Google competes with other companies and offers a product to publishers. To interact with advertisers, publishers must acquire products from both the first and second markets. Furthermore, Google was found to leverage its dominant position in the first market to enhance its sales in the second. Thus, the SSP market corresponds to the ancillary product market in my model, while the other layers of the adtech stack correspond to the primary market. Accordingly, publishers correspond to sellers in the basic model who purchase ancillary products, while advertisers correspond to buyers who interact with sellers.

Figure 5: Google adtech Market



According to the basic model, when it is profitable for Google to practice self-preferencing, sellers benefit from self-preferencing. Therefore, alleviating self-preferencing is expected to diminish the surplus of publishers in the adtech industry. As for buyers, my model suggests that they also benefit from self-preferencing unless there is a competing firm highly preferred by buyers. Therefore, when Google alleviates self-preferencing in the adtech market, advertisers are expected to experience a lower surplus unless they can derive a higher value from interacting with some non-Google technologies.

Given that there was a significant drop in advertiser participation in France following the data-sharing commitment, I anticipate that advertisers dislike interacting with non-Google technologies. This belief is confirmed by recent findings published by the EC and DOJ. Parallel to the FCA, the EC and DoJ also investigated into Google's self-preferencing in the adtech industry. Although both cases are ongoing, with no regulations yet implemented by the time of my research, their investigation results and preliminary opinions complement the FCA's evaluations.

In Europe, the EC opened a formal investigation against Google in June 2021. Similar to the FCA, the EC also found that Google's ad server (DFP) favored its SSP (AdX) by providing more advantageous terms compared to rivals. However, unlike the FCA, the EC expanded its examination to include the advertiser side. In its Statement of Objections, the EC pointed out that Google's self-preferencing practices are not limited to the publisher side but also spread to the advertiser side. For instance, Google's adtech services for advertisers, such as Google Ads and DV 360, had been favoring AdX by limiting their ad auction bids on rival SSPs.[25]

Based on these findings, the EC doubts the efficacy of behavioral remedies in deterring Google from adopting new self-preferencing practices. The commission strongly emphasized the need for a more effective solution to address Google's abusive practices in the adtech industry, suggesting that the most impactful approach to address competitive concerns might involve a mandatory divestment of specific services by Google. Compared to behavioral remedies, the structural approach is expected to be more effective in eliminating Google's self-preferencing motivation and restoring competition in the adtech industry.

In the US, the DoJ filed an antitrust suit against Google in January 2023.[26] As pointed out by the DoJ, Google has been monopolizing the adtech market through a series of anticompetitive strategies, including: (i) engaging in a pattern of acquisitions to gain control over key digital advertising tools used by website publishers to sell advertising space; (ii) locking in website publishers to its newly acquired tools by restricting access to its unique, must-have advertiser demand through its ad exchange, and conditioning effective real-time access to its ad exchange on the use of its publisher ad server; (iii) limiting real-time bidding on publisher inventory to its ad exchange and hindering rival ad exchanges from competing on equal terms; and (iv) manipulating auction mechanics across several products to insulate Google from competition, deprive rivals of scale, and prevent the rise of competing technologies.

Because of Google's abusive practices, the DoJ initiated its antitrust trial against Google in September 2024.[27] The government argues that Google has endowed its technologies with unfair advantages in the programmatic advertising ecosystem. By controlling both the selling mechanisms for publishers and the bidding algorithms for advertisers, Google can manipulate the market. Similar to the EC, the DoJ in the trial has also called for the divestment of Google's adtech layers on the publisher side.

The EC and DoJ both point out that Google's preferential treatment of AdX extends to the advertiser side, making advertisers derive lower value if interacting with publishers using non-Google ad technologies. Under such market conditions, the data patterns observed in France align closely with my theoretical predictions, which suggest that alleviating self-preferencing reduces the surplus of both buyers (advertisers) and sellers (publishers) unless buyers have a strong preference for competing (non-Google) adtech. The exception seems unlikely, as the EC and DoJ have pointed out that advertisers dislike interacting with publishers using non-Google adtech due to Google's self-preferencing practice on the advertiser side.

[25]See https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3207.
[26]See https://www.justice.gov/opa/pr/justice-department-sues-google-monopolizing-digital-advertising-technologies.
[27]See https://www.forrester.com/blogs/us-v-google-the-ftc-takes-on-adtech-verticalization/.

5 Counterfactural Analysis

Given that self-preferencing regulations may backfire, it is natural to question whether such regulation is necessary. If the regulation is indeed needed, it then becomes critical to determine how to do it effectively. I next present two counterfactual exercises to explore these aspects. The first exercise explores the long-term self-preferencing impact in the absence of regulation. The second exercise investigates if the divestment intervention proposed by the EC and DoJ is more efficient than behavioral remedies in France.

5.1 Long Run Impact

To simplify without loss of generality, I focus on a simple scenario where $\beta_b = 0$. This corresponds to a market in which buyers perceive all sellers and ancillary products as identical.[28] As illustrated in the basic model, the practice of self-preferencing diminishes competing firms' profit and discourages their entry in the long run. Thus, without regulation, the gatekeeper firm G may gradually monopolize the ancillary product market as well. If the ancillary product is provided solely by firm G, it is optimal for firm G to continue increasing its price until the seller whose ideal product is the 3P ancillary product derives zero surpluses. In other words, the primary and ancillary products can now be viewed as a bundle with the equilibrium price of $p_G + m_S = v_G^s - t$, and the resulting profit of the gatekeeper firm now equals $\pi_G^* = t(2v_G^s - 2t)/4$.

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

$$n_B^* = v_G^b \text{ and } n_S^* = \frac{t}{2}.$$

Comparing it with the basic model, I find that both buyers and sellers derive lower surplus and are discouraged from entering the market as long as the value of joining the market is not too small, specifically, $v_G^s > (2\beta_s t + 21t^2 - \beta_s^2)/(12t)$. The results highlight that while self-preferencing in a competitive ancillary product market may not generate welfare loss in the short run, its evolution into a monopoly market, in the long run, can have serious detrimental impacts on social welfare. Therefore, the practice of self-preferencing should be carefully monitored and regulated by policymakers.

[28]The relaxation of the assumption $\beta_b = 0$ does not change conclusions.

5.2 Divestment Remedy

A follow-up question is how to effectively regulate self-preferencing practice. Unlike the FCA, the EC and DoJ propose a mandatory divestment of Google's adtech services. It is uncertain whether divestment is more effective than behavioral (non-structural) remedies. Compared to non-structural interventions, the divestment approach is expected to be more effective in eliminating Google's motivation for self-preferencing. However, considering the intricate market structure of the adtech industry, uncertainties persist regarding how this structural remedy might impact social welfare.

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

$$\begin{aligned}
\Delta EQ &= EQ'(\beta_s', \beta_b') - EQ(\beta_s, \beta_b), \\
&= EQ'(\beta_s', \beta_b') - EQ(\beta_s', \beta_b') + EQ(\beta_s', \beta_b') - EQ(\beta_s, \beta_b), \qquad (11)\\
&\approx \underbrace{EQ'(\beta_s', \beta_b') - EQ(\beta_s', \beta_b')}_{\text{changes due to market structure}} + \underbrace{\frac{\partial EQ(\beta_s, \beta_b)}{\partial \beta_b}(\beta_b' - \beta_b)}_{\beta_b \text{ changes due to self-preferencing removal}} + \underbrace{\frac{\partial EQ(\beta_s, \beta_b)}{\partial \beta_s}(\beta_s' - \beta_s)}_{\beta_s \text{ changes due to self-preferencing removal}},
\end{aligned}$$

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 and β_b measures the relative value of 3P ancillary product for sellers and buyers before the intervention, and β_s' and β_b' measures the relative value of 3P ancillary product for sellers and buyers after the intervention.

As shown in Equation 11, the overall market change following divestment can be categorized into three effects. First, given the ancillary product values, the equilibrium strategy changes due to modifications in market structures. Second, given the market structure and equilibrium strategy, buyers' value of 3P ancillary products may improve as self-preferencing incentives are removed. Third, similar to the buyer side, sellers' value of 3P ancillary products may also improve following divestment. The third effect, driven by an improvement in sellers' value over 3P products, is qualitatively similar to the FCA's regulation and has been well-studied in previous analyses. Therefore, the focus in this section shifts to the first two effects—how changes in market structure and buyers' valuation of 3P products influence market outcomes.

To study the first effect, I analyze the scenario where the ownership of the 1P ancillary product is switched from firm G to a different company, denoted as firm B. By comparing the market equilibrium before and after the ownership change, I shed light on the changes in market outcomes induced by market structure modification. 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 the basic model. Accordingly, sellers' demand for market participation also remains to be the same.

After divestment, firm G only collects the profit from selling the primary product. Maximizing its profit, I derive the market equilibrium. To investigate welfare implications, I next compare the market participation before and after the divestment. On the seller side, the change in market participation is given by:

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

where n_S^{d*} denotes seller participation after divestment, and Δn_S^I measures the change of seller participation induced by market structure modification. On the buyer side, I find that $\Delta n_B^I = n_B^{d*} - n_B^* = 0$, where n_B^{d*} is buyer participation after divestment, and Δn_B^I measures the change of seller participation induced by market structure modification.

As for the competing firms in the adjacent market, the change in their profit following divestment is given by:

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

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

The results suggest that the market structure modification induced by divestment always diminishes seller surplus and their participation in the market. Moreover, competing firms tend to experience lower profits after divestment. In the long run, the negative impact on competing firms may speed up their exit, ultimately reducing overall competition in the ancillary product market.

To investigate the second effect, I approximate the change in market participation (Equation 6-7) when the value of 3P products is improved for buyers:

$$\begin{aligned}
\Delta n_B^I &= \frac{\partial n_B^*}{\partial \beta_b}(\beta_b' - \beta_b) = \frac{(2\beta_s - 6t)}{12t}(\beta_b' - \beta_b) > 0, \\
\Delta n_S^I &= 0.
\end{aligned}$$

I find that the second effect induced by an improvement in buyers' value for 3P ancillary products positively affects buyer surplus.

Translating the findings to the context of the adtech industry, the first effect in Equation (11), i.e., the impact of market structure change resulting from divestment, always diminishes the surplus of publishers and competing firms' profits in the display advertising market. This is because divestment decreases the profit each publisher brings to the gatekeeper firm. Consequently, firm G's incentive to attract publisher and advertiser participation diminishes, leading to decreased aggregate demand for SSPs and reduced profits for all firms. In contrast, the second effect in Equation (11), i.e., the impact of 3P ancillary product value improvement for buyers, always benefits advertisers.

Thus, compared to behavioral remedies, whose impacts are largely captured in the third effect, divestment regulation can be either more or less effective in improving social welfare. If divestment only increases the value of third-party products for publishers without affecting advertisers—i.e., when the second effect is absent—such a structural remedy may reduce social welfare by an even greater magnitude than behavioral regulations. However, if divestment significantly enhances the value of third-party ancillary products for advertisers and leads to a sufficiently large second effect, the divestment remedy can more effectively improve social welfare than behavioral regulations.

6 Extensions

Before I conclude, I explore two extensions in this section. First, I investigate how network effects in two-sided markets influence the impact of self-preferencing. Second, I examine a market scenario where the primary product is no longer free for buyers.

6.1 Network Effect

As highlighted in existing literature, a critical characteristic of two-sided markets is the presence of network effects: a user's surplus from joining the market depends on the participation of the other group. In this section, I incorporate the network effects into the model and derive qualitatively similar conclusions to the basic model: when self-preferencing is profitable for the gatekeeper, sellers benefit. However, there may be negative effects on buyers if they highly dislike the 1P ancillary product. I also show that the introduction of network effects can either enhance or diminish the gatekeeper firm's motivation for self-preferencing, depending on buyers' preferences regarding ancillary products. Additionally, given that self-preferencing benefits the gatekeeper, positive network effects reduce the likelihood of harm to buyers.

When there are network effects, each seller anticipates a higher profit/surplus as more buyers join the market. These network effects are captured by the linear expression $e_s n_B$, where $e_s > 0$ measures the strength of the network effects. Combining the network effects with sellers' surplus in the basic model, the total surplus of seller j is now equal to:

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

Similarly, on the buyer side, network effects are represented by $e_b n_S$, where e_b measures the magnitude of network effects derived from each seller. Accordingly, a buyer's total expected utility from joining the market is given by $U_b = e_b n_S + v_i^b$ if her transaction is fulfilled by the ancillary product from firm $i \in \{G, 1, 2, ..., N\}$.

As shown in Appendix B, I follow the same steps as in the basic model and find that network effects can either increase or decrease the gatekeeper's incentive for self-preferencing:

Property 5. *In a two-sided market with positive network effects, network effects enhance the gatekeeper's incentive for self-preferencing when buyers prefer the 1P ancillary product over the 3P ancillary product, and reduce its incentive otherwise. Specifically, the practice of self-preferencing is profitable for firm G when $t < \beta_s + e_s\beta_b$, and non-profitable otherwise.*

With network effects, firm G's strategy regarding self-preferencing is jointly determined by both buyers and sellers. If buyers exhibit a growing preference for 1P sellers over 3P sellers, self-preferencing motivates more sellers to use the ancillary products favored by buyers. Consequently, the effect of self-preferencing on buyer participation becomes positive when this preference is sufficiently strong. Conversely, when buyers prefer 3P sellers over 1P sellers, self-preferencing directs more sellers toward the ancillary products that buyers dislike, thereby discouraging buyer participation. Due to positive network effects, the impact of self-preferencing on buyer participation extends to the seller side. Hence, the network effects reinforce firm G's motivation for self-preferencing when buyers prefer its 1P ancillary product and diminish it otherwise.

As for the surplus of buyers and sellers, I derive similar results as shown in Property 6.

Property 6. *In a two-sided market with positive network effects,*

- *self-preferencing increases seller participation when $t < \beta_s + e_s\beta_b$ and decreases otherwise;*
- *self-preferencing increases buyer participation when $\beta_b > \frac{e_b(t-\beta_s)}{2-e_b e_s}$ and decreases otherwise.*

Combining the results in Property 5 and Property 6, I find qualitatively similar conclusions to the basic model: the gatekeeper's motivation for self-preferencing aligns with sellers' interests. However, the gatekeeper's motivation for self-preferencing can conflict with buyers' interests, even when buyers benefit from positive network effects.

Property 7. *In a two-sided market with positive network effects, if firm G finds self-preferencing profitable, then 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.*

As illustrated in Property 7, the introduction of network effects reduces the cutoff of buyers' preference over 1P product, above which buyers benefit from self-preferencing. In other words, given that the gatekeeper finds it profitable to practice self-preferencing, buyers are more likely to benefit in the presence of positive network effects. This is due to the fact that seller participation is always encouraged after self-preferencing, and this increase in seller size benefits buyers through cross-group network effects. Consequently, in addition to its impact on buyers through the redistribution of sellers among ancillary products in the basic model, self-preferencing now provides an additional positive effect on buyers through network effects. Thus, buyers are more likely to be better off following self-preferencing.

6.2 Buyer Fee in Primary Market

In the basic model, the primary product is free for buyers. This is motivated by the observation that many gatekeepers, like Amazon, YouTube, and Airbnb, are willing to provide free intermediation services for buyers. In this section, I explore the possibility that the gatekeeper firm charges both buyers and sellers in the primary market and investigate the impact of self-preferencing in this context.

Specifically, if a buyer's transaction is fulfilled by the ancillary product from firm $i \in \{G, 1, 2, ..., N\}$, her total expected utility from joining the market is given by $U_b = v_i^b - m_B$, where m_B is the charge of the primary product for buyers. The gatekeeper firm G now can maximize its profit by choosing the primary product charge for both buyers and sellers. Accordingly, its profit becomes $\pi_G = m_B n_B + m_S n_S + p_G Q_G$. All other setups remain the same as in the basic model.

The primary product charge on buyers does not affect the self-preferencing impact on user surplus. As illustrated in Appendix C, when the gatekeeper charges both buyers and sellers, the impact of self-preferencing on user participation remains the same as in the basic model. As for the gatekeeper's motivation for self-preferencing, the conclusion is also qualitatively similar as shown in the following Property.

Property 8. *If firm G charges both buyers and sellers in the primary market, there exists a cutoff $\bar{t}_b$ such that the practice of self-preferencing is profitable for firm G when $t < \bar{t}_b$, and non-profitable otherwise.*

As the gatekeeper now charges both buyers and sellers in the primary market, its strategy regarding self-preferencing is jointly determined by buyers' and sellers' preferences for ancillary products. When buyers prefer 1P sellers over 3P sellers, firm G is more likely to engage in self-preferencing than in the basic model, i.e., $\bar{t}_b > \beta_s$. However, when buyers prefer 3P sellers over 1P sellers, the motivation for self-preferencing diminishes, i.e., $\bar{t}_b < \beta_s$. In this context, it is still possible for both buyers and sellers to benefit from self-preferencing under specific conditions. The findings can be summarized as shown in Property 9.

Property 9. *In a two-sided market where firm G charges both buyers and sellers for the primary product, if firm G finds self-preferencing profitable, then both buyers' and sellers' surplus can either increase or decrease following self-preferencing. Precisely,*

- *if buyers prefer 3P sellers and 1P sellers ($\beta_b < 0$), then self-preferencing always increases sellers' surplus while decreasing buyers' surplus;*
- *if buyers prefer 1P sellers and 3P sellers ($\beta_b > 0$), then self-preferencing*
  - *always increases both sellers' and buyers' surplus when $\beta_s > t$, and*
  - *increases buyers' surplus while decreasing sellers' surplus when $\beta_s < t$.*

7 Conclusions

In this study, I analyze a phenomenon that has recently emerged and raised significant antitrust concerns in digital markets. Several competition authorities found that gatekeepers, like Google, Amazon, and Apple, have been leveraging their dominant power in core services to rapidly gain market share in newly developed adjacent markets. This form of self-preferencing, which spans across markets, is distinct from the typical self-preferencing in existing literature. The phenomenon involves complicated market structures and quite different tradeoffs.

By analyzing a recent antitrust case against Google, I observe a sharp drop in the surplus of both advertisers and publishers following self-preferencing regulations. To investigate, I develop a simple model to study the impact of self-preferencing and its potential determinants. The findings I present indicate that self-preferencing is not always profitable for the gatekeeper. Moreover, its welfare implications are complicated. In the adjacent market, self-preferencing normally discourages the entry of competing firms and diminishes competition. In the primary market, if buyers strongly dislike the gatekeeper's ancillary products, self-preferencing harms buyers despite being profitable for the gatekeeper. Surprisingly, sellers' interests are congruent with the gatekeeper's strategy, meaning that sellers benefit when self-preferencing is profitable for the gatekeeper. Hence, the practice can be beneficial for both buyers and sellers unless there exists a strong competitor providing sufficiently high-quality service to buyers.

The findings provide critical insights into an important phenomenon in digital markets and contribute to ongoing policy discussions. The three key elements of my analysis are: first, a novel dataset that offers the first empirical evidence for regulating self-preferencing in the adtech industry; second, a tractable model that captures the main features of a newly emerging type of phenomenon in digital markets; and third, counterfactual exercises providing valuable insights for policymakers regarding regulation designs.

I conclude the paper by briefly discussing two applications. First, Apple was recently fined by the European Commission (EC) for preventing music streaming app developers from fully informing iOS users about alternative and cheaper subscription services available outside of their apps. [29] In response, in August 2024, Apple revised its policy in the European Union to allow developers to communicate with their customers outside of the App Store. Concurrently, Apple introduced two new fees: an initial 5% acquisition fee for new users and a 10% store services fee on any sales made by app users on any platform within the first 12 months of app installation.[30] This observations closely align with the paper's finding that self-preferencing enhances gatekeepers' incentives to reduce primary product fees in exchange for increased market participation. As each user attracted to the mobile market has a greater chance of using competing products after regulation, Apple's effort to attract market participation is discouraged and chooses to charge more from the primary market.

Second, although the paper focuses on the self-preferencing phenomenon, its findings apply to other issues in ancillary product markets. For instance, as highlighted in my analysis of divestment, consumers may experience a lower surplus if there is a misalignment between the gatekeeper's and ancillary product firms' incentives to attract consumers. This finding aligns with recent observations

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

[30] See https://www.theguardian.com/technology/article/2024/aug/09/apple-changes-eu-app-store-communication.

on Temu, a Boston-based, Chinese-owned shopping app. Since its launch in 2022, Temu has invested heavily in expanding its market share, frequently holding the top spot for mobile downloads among both Apple and Android users over the past two years.[31] Despite its popularity, Temu has faced significant criticism regarding its ancillary services. As pointed out by Time[32]: "Temu has had trouble delivering within the promised time window." In 2023, the company had a C rating from the Better Business Bureau (BBB) and an average customer rating of 1.4 out of 5 stars. Unlike Amazon, Temu does not have its own logistics network and relies heavily on external shipping providers like UPS, USPS, and FedEx. Temu's rapid market expansion has significantly increased demand for shipping, with carriers reportedly handling around 900,000 packages per day in the U.S.[33] However, external logistics providers have not scaled their investments to keep up with this growth. As a result, consumers suffer from the disconnect between Temu's aggressive market expansion and the insufficient investment by external shipping companies to handle the increased demand.

Beyond my findings, several other extensions can be explored in the future. My model concentrates on 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, further investigation into the impact of FCA regulation on advertisers or publishers who multihome across adtechs would be interesting. Lastly, the paper mainly concentrates on a monopoly setting where the gatekeeper dominates the primary product market. Examining how self-preferencing in the ancillary product market influences firms' entry into the primary market would also be a promising area of study.

[31] See https://www.cbc.ca/news/business/key-things-to-know-about-temu-online-shopping-1.6850217

[32] See https://time.com/6243738/temu-app-complaints/

[33] See https://www.supplychaindive.com/news/temu-shein-shipping-delivery-industry-impact/725215/.

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A Proofs

A.1 Proof of Property 1

According to Equations (1-2), it is evident that an increase in β_s increases p_G while decreasing p_C. To examine the impact of β_s on the primary product price 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 primary product price m_S.

A.2 Proof of Property 2

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

$$\frac{dn_S}{d\beta_s} = \frac{\beta_s - t}{12t}.$$

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 buyer participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{\beta_b}{6t}.$$

Therefore, the sign of $dn_B/d\beta_s$ is positive when $\beta_b > 0$, and is the opposite otherwise.

A.3 Proof of Property 3

I first check how the monopoly firm's profit changes when β_s increases. Calculating the derivation of the firm G's profit with respect to β_s, I derive:

$$\frac{d\pi_G}{d\beta_s} = \frac{(\beta_s - t)(\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s))}{144t^2}.$$

Since the denominator is always positive, the sign of $d\pi_G/d\beta_s$ is determined by the numerator $(\beta_s - t)(\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s))$. Under Assumption 1, the equation $\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s)$ is always positive. Therefore, $d\pi_G/d\beta_s$ is positive if $t < \beta_s$ and negative otherwise.

As for the profit of fringe firms, its derivative equals

$$\frac{d\pi_C}{d\beta_s} = \frac{(\beta_s - 3t)(\beta_s^2 - 3\beta_s t - 3t(t - 2v_G^s))}{108t^2}.$$

Since $|\beta_s| < 3t$ under Assumption 1, equation $(\beta_s - 3t)$ is always negative. Hence, the sign of $d\pi_C/d\beta_s$ is determined by the convex function $H_C = \beta_s^2 - 3\beta_s t - 3t(t - 2v_G^s)$ in β_s. Under Assumption 1, the value of H_C is always positive when β_s reaches the minimum value $(-3t)$ and the maximum value $(3t)$. Moreover, I calculate the function's minimum value at $\beta_s = 3t/2$ and derive also positive value. Consequently, the profit of competing firms always diminishes following self-preferencing.

B Market with Network Effects

Based on the model setup in Section 6.1, I solve for the subgame perfect equilibrium. To avoid trivial market equilibria, I make the following assumptions in this section:

Assumption 2. *In a two-sided market with network effects, I assume:*

- ***[Profit Concavity]*** *the network effects satisfy $e_s > 0$, $e_b > 0$, and $e_b e_s < 1$ to guarantee profit concavity;*
- ***[Postive Demand]*** *the product values satisfy $|\beta_s| < 3t$ so that both 1P product and 3P product derive a positive demand at equilibrium; and*
- ***[Competitive Market]*** *the surplus is sufficiently large, such that there exists competition between the 1P ancillary product and 3P ancillary product.*[34]

The introduction of network effects does not affect the transaction stage between sellers and firms in the adjacent market, thus the demand and firms' pricing strategy over ancillary products stay the same as in the basic model. However, buyers and sellers' market participation change. Precisely, a seller's expected surplus from joining the market, denoted as $E[U_s]$, equals:

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

As for buyers, their expected utility depends on the distribution of sellers among ancillary products and can be written as:

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

Users in both groups will join the market if they expect to derive a higher surplus than their outside options. Hence, the demands for market participation in both groups are given by $n_S = E[U_s]$ and $n_B = E[U_b]$.

[34]This requires $v_G^s + e_s v_G^b > (18 e_s \beta_b t + 6\beta_s t + 45t^2 - 6 e_s \beta_b \beta_s - \beta_s^2 - 2 e_b e_s \beta_s^2 - 18 e_b e_s t^2)/36t$.

Given the ancillary product prices (expression 1-2) and demands (expression 3-4) at equilibrium, the explicit demands for market participation can be expressed as:

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

Maximizing firm G's profit by solving the first-order condition, I derive the profit-maximizing primary product price as:

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

Accordingly, the equilibrium demands for market participation are given by:

$$
\begin{aligned}
n_B^* &= \frac{(2\beta_b\beta_s + 12tv_G^b - 6\beta_b t)(2 - e_b e_s) + e_b\beta_s(\beta_s - 2t) - 9e_b t^2 + 12e_b tv_G^s}{24t(1 - e_b e_s)}, \\
n_S^* &= \frac{2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_b t - 2\beta_s t - 9t^2 + 12e_s tv_G^b + 12tv_G^s}{24t(1 - e_b e_s)},
\end{aligned}
$$

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

I lastly calculate the equilibrium profits of firms and derive:

$$
\begin{aligned}
\pi_G^* &= \frac{(-2e_s\beta_b\beta_s - \beta_s^2 + 6e_s\beta_b t + 2\beta_s t + 9t^2 - 12e_s tv_G^b - 12tv_G^s)^2}{576t^2(1 - e_b e_s)}, \\
\pi_C^* &= \frac{(3t - \beta_s)^2(-2e_s\beta_b\beta_s - \beta_s^2 + 6e_s\beta_b t + 2\beta_s t + 9t^2 - 12e_s tv_G^b - 12tv_G^s)}{432Nt^2(1 - e_b e_s)} - L.
\end{aligned}
$$

To investigate the impact of self-preferencing on market competition, I calculate 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 2, 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 buyer 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 2, 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 $t > \beta_s + \frac{2-eB-e_s}{e_b}\beta_b$.

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

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

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

C Buyer Fee in Primary Market

Based on the model setup in Section 6.2, I solve for the subgame perfect equilibrium. To avoid trivial market equilibria, I make the following assumption.

Assumption 3. *In a two-sided market where the gatekeeper charges both buyers and sellers in the primary market, I assume buyers' standalone value is not too low so there is positive market entry:* $v_G^b > (3\beta_b t - \beta_b\beta_s)/6t$.

The introduction of network effects does not affect the transaction stage between sellers and firms in the adjacent market, thus the demand and firms' pricing strategy over ancillary products stay the same as in the basic model. However, buyers and sellers' market participation change.

When the primary product is no longer free, the demands for market participation are affected and can be written as:

$$
\begin{aligned}
n_S &= -m_S + \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)}(v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^{1}(v_G^s - \beta_s - p_k - t(1-x))dx\right)\frac{1}{N},\\
n_B &= -m_B + \sum_{k=1}^{N}\left(q_G(k)v_G^b + (1-q_G(k))(v_G^b - \beta_b)\right)\frac{1}{N}.
\end{aligned}
$$

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

$$
\begin{aligned}
n_B &= v_G^b - m_B + \frac{\beta_b(\beta_s - 3t)}{6t},\\
n_S &= v_G^s - \frac{\beta_s}{2} - m_S + \frac{\beta_s^2}{36t} - \frac{5t}{4}.
\end{aligned}
$$

Given the demands, I next examine firm G's optimal pricing strategy in the primary market. For firm G, which now sells the primary product to both groups, its profit (π_G) is expressed as:

$$
\pi_G = m_B n_B + m_S n_S + \sum_{k=1}^{N} p_G \frac{(\beta_s - p_G + p_k + t)n_S}{2Nt}.
$$

Maximizing its profit, the gatekeeper's equilibrium price in the primary market can be derived as follows.

$$m_B^* = \frac{\beta_b\beta_s - 3\beta_b t + 6tv_G^b}{12t},$$
$$m_S^* = \frac{36tv_G^s - \beta_s^2 - 30\beta_s t - 63t^2}{72t}.$$

To investigate the welfare implication of self-preferencing, I calculate the equilibrium demands for market participation and derive:

$$\begin{aligned} n_B^* &= \frac{\beta_b\beta_s - 3\beta_b t + 6tv_G^b}{12t}, \\ n_S^* &= \frac{\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s}{24t}. \end{aligned}$$

Analyzing how n_B^* and n_S^* evolve when firm G practices self-preferencing, I find qualitatively similar findings to Property 2.

$$\begin{aligned} \frac{\partial n_B^*}{\partial \beta_s} &= \frac{\beta_b}{12t}, \\ \frac{\partial n_S^*}{\partial \beta_s} &= \frac{\beta_s - t}{12t}. \end{aligned}$$

As for the impact of self-preferencing on firm G's profit, the corresponding derivative can be written as:

$$\frac{\partial \pi_G^*}{\partial \beta_s} = \underbrace{\frac{2\beta_b(\beta_b\beta_s - 3\beta_b t + 6tv_G^b)}{144t^2}}_{\text{First Component}} + \underbrace{\frac{(\beta_s - t)(\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s))}{144t^2}}_{\text{Second Component}}.$$

Following the same steps as in the basic model, we can easily show that the second component is decreasing in t. Precisely, the value of the second component is positive when $t < \beta_s$ and is positive otherwise. As for the first component, the value of $(\beta_b\beta_s - 3\beta_b t + 6tv_G^b)$ is always positive under Assumption 3. Thus, if $\beta_b > 0$, the first component is always positive. Accordingly, the transportation cost cutoff $\bar{t}_b$ below which the gatekeeper firm chooses to practice self-preferencing must increase and be higher than β_s. In contrast, if $\beta_b < 0$, the first component is always negative. Accordingly, the transportation cost cutoff below which the gatekeeper firm chooses to practice self-preferencing must decrease and be lower than β_s.

D Robustness Check

D.1 Horizontal Differentiation

In the main text, I assume that each seller considers two ancillary products: one is always the 1P product, and the other is a randomly selected 3P product. The horizontal differentiation between these products is fixed and unaffected by the firms' entry into the adjacent market. In this section, I relax this assumption and explore whether my main conclusions still hold.

To incorporate the impact of firms' entry on the horizontal differentiation between ancillary products, I denote the length of the Hoteling line as $b(N)$, a function of the number of competing firms in the adjacent market. All other setups remain the same as the basic model. Within this setup, the competitive adjacent market condition in Assumption 1 changes to be $v^s_G > (6\beta_s bt + 45b^2t^2 - \beta_s^2)/36tb$.

I then solve for the subgame perfect equilibrium. If firm G 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:

$$\bar{\theta}(k) = \frac{\beta_s + p_k - p_G + bt}{2t}.$$

Correspondingly, the demands for the two ancillary products can be expressed as:

$$Q_G = \sum_{k=1}^{N} \bar{\theta}(k)\frac{n_S}{N} = \sum_{k=1}^{N} \frac{(\beta_s + p_k - p_G + bt)}{2t}\frac{n_S}{N},$$
$$Q_k = \left(1 - \bar{\theta}(k)\right)\frac{n_S}{N} = (b - \frac{\beta_s + p_k - p_G + bt}{2t})\frac{n_S}{N}.$$

Given the product prices, buyers and sellers make entry decisions and their demand for market participation can be solved as:

$$n_S = -m_S + \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} b(v^s_G - p_G - tx)dx + \int_{\bar{\theta}(k)}^{b} (v^s_G - \beta_s - p_k - t(1-x))dx\right)\frac{1}{bN},$$
$$n_B = \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} v^b_G dx + \int_{\bar{\theta}(k)}^{b} (v^b_G - \beta_b)dx\right)\frac{1}{bN}.$$

Each firm maximizes its profit simultaneously and the equilibrium prices are given by:

$$\begin{aligned} p_G &= bt + \frac{\beta_s}{3}, \\ p_C &= bt - \frac{\beta_s}{3}, \end{aligned}$$

and the resulting ancillary product demands are:

$$\begin{aligned} Q_G &= (\frac{b}{2} + \frac{\beta_s}{6t})n_S, \\ Q_C &= (\frac{b}{2} - \frac{\beta_s}{6t})\frac{n_S}{N}. \end{aligned}$$

Lastly, I proceed to analyze firm G's pricing strategy over the primary product. Plugging in the equilibrium demands and prices, the explicit demands for market participation can be expressed as:

$$\begin{aligned} n_B &= \frac{\beta_b(\beta_s - 3t) + 6tv_G^b}{6t}, \\ n_S &= \frac{\beta_s^2 - 18\beta_s t - 36tm_S - 45t^2 + 36tv_G^s}{36t}. \end{aligned}$$

Maximizing firm G's profit by solving the first-order condition, I derive the profit-maximizing primary product price as:

$$m_S^* = \frac{-\beta_s^2 - 30\beta_s bt - 63b^2t^2 + 36btv_G^s}{72bt}.$$

Given the equilibrium pricing strategies, the demands for market participation are given by:

$$\begin{aligned} n_B^* &= \frac{\beta_b\beta_s + 6tbv_G^b - 3\beta_b bt}{6bt}, \\ n_S^* &= \frac{\beta_s^2 - 2\beta_s bt - 9t^2 + 12btv_G^s}{24bt}, \end{aligned}$$

and the resulting equilibrium profits of firms and derive:

$$\pi_G^* = \frac{(-\beta_s^2 + 2\beta_s bt + 9b^2t^2 - 12btv_G^s)^2}{576bt^2},$$
$$\pi_C^* = \frac{(3bt - \beta_s)^2(-\beta_s^2 + 2\beta_s bt + 9b^2t^2 - 12btv_G^s)}{432bNt^2} - L.$$

Based on the market equilibrium, I first investigate firm G's motivation for self-preferencing. Precisely, I find that firm G is incentivized to engage in self-preferencing when $t < \beta_s/b$. Furthermore, analyzing market participation, I derive results qualitatively similar to the basic model: sellers benefit from self-preferencing as long as it is profitable for firm G, i.e. when $t < \beta_s/b$. However, buyers may be harmed by self-preferencing when they dislike the 1P ancillary product, i.e., $\beta_b < 0$, and benefit from it otherwise.

Note that I now allow b to be endogenously determined by firm entry so the horizontal differentiation is also affected accordingly. However, since the cutoffs for both firm G and sellers to benefit from self-preferencing are equal, any change in b simply shifts the two cutoffs simultaneously without affecting their relationship. Therefore, allowing horizontal differentiation to vary with the number of competing firms in the ancillary product market does not alter the paper's main conclusion.

D.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., $v_G^s + v_k^s = v^s$. Combining this condition with $v_k^s = v_G^s - \beta_s$, we have $v_G^s = (v^s + \beta_s)/2$ and $v_k^s = (v^s - \beta_s)/2$, with $\beta_s > 0$. Moreover, I take into account the network effects in the analysis. All other setups remain the same as in the basic model.

As the competition between ancillary products is determined solely by their vertical difference $v_G^s - v_k^s$, 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 basic model. The impact of self-preferencing is also the same: the practice of self-preferencing increases the price of the 1P ancillary product while decreasing that of 3P ancillary products. Additionally, given the market 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 market participation. Specifically, given $v_G^s + v_k^s = v^s$, the demand for market participation can be simplified as follows:

$$n_B = \frac{\beta_b(\beta_s - 3t) + 6tv_G^b}{6t}, \tag{12}$$

$$n_S = \frac{\beta_s^2 - 18\beta_s t - 36tm_S - 45t^2 + 18tv^s}{36t}. \tag{13}$$

Based on the demand functions, the gatekeeper firm then chooses the optimal primary product price to maximize its profit:

$$m_S^* = \frac{-\beta_s^2 - 12\beta_s t - 63t^2 + 18tv_G^s}{72t},$$

Correspondingly, the equilibrium profit of firm G is:

$$\pi_G^* = \frac{(\beta_s^2 + 4\beta_s t - 9t^2 + 6tv^s)^2}{576t^2},$$

and the equilibrium demands for market participation are:

$$n_B^* = \frac{\beta_b(\beta_s - 3t) + 6tv_G^b}{6t},$$

$$n_S^* = \frac{\beta_s^2 + 4\beta_s t - 9t^2 + 6tv^s}{24t}.$$

To investigate the impact of self-preferencing on social welfare, I examine how buyers' and sellers' market 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 market, indicating an improvement in their welfare following the self-preferencing practice. Otherwise, it is the opposite.

My analysis shows results that are qualitatively similar to the basic model. First, under the condition that self-preferencing is profitable for the gatekeeper firm, i.e., $\beta_s > -2t$, 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 dislike 1P sellers and $\beta_b < 0$, self-preferencing will make buyers worse off. Otherwise, it is the opposite.

D.3 Transaction Fee

In the main text, I abstract away the transactions between buyers and sellers. Also, I assume that primary and ancillary product charges are based on seller participation. In this section, I allow ancillary products to be sold per transaction. To integrate this, I extend the model to incorporate the transaction stage between buyers and sellers, letting the primary and ancillary product charges depend on transactions. This extension is primarily motivated by the EC's recent regulation regarding Amazon's self-preferencing in logistics services. In the following analysis, I first introduce the institutional background of the EC Amazon case, and then extend my basic model accordingly.

Institutional Background 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 than Amazon's shipping network.

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."

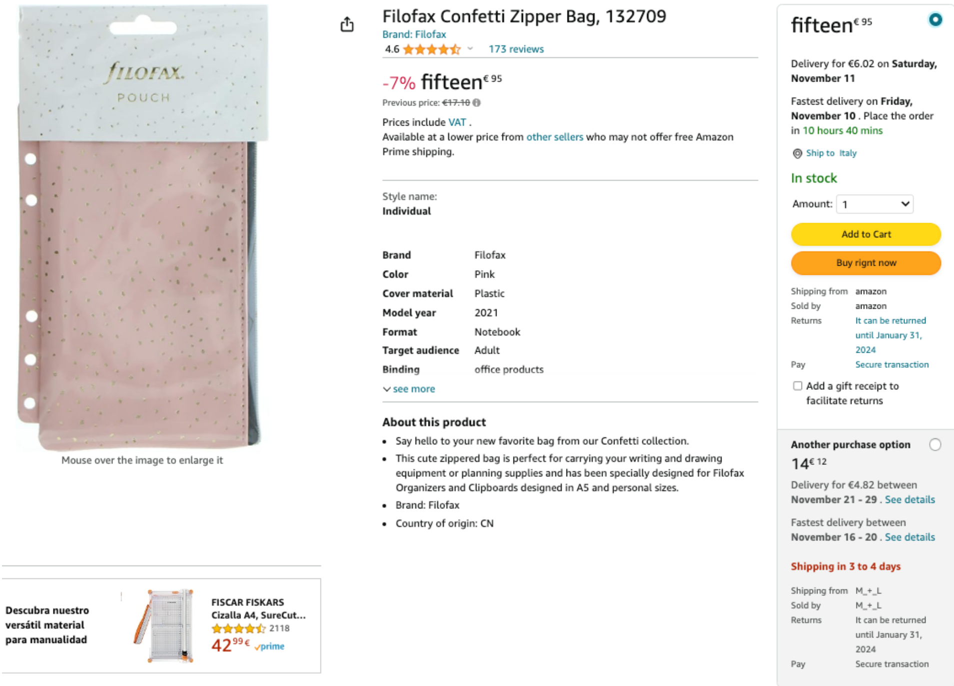
These benefits all play critical roles in facilitating transactions on Amazon. For instance, one important advantage of FBA sellers is their higher chance of winning the Buy Box. Unlike others, sellers who win the Buy Box can be immediately added to buyers' shopping carts through the "Add to Basket" button or be purchased directly through the "Buy Now" button. Due to this convenience, most Amazon sales 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."[35]

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 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 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.

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

Figure A.1: Amazon Second Buy Box Offer



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 A.1.

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.[36] As shown in Figure A.2, Amazon also informed sellers that its Prime eligibility will be updated in Germany, France, Spain, Netherlands, Poland, Sweden, and Belgium after June 21st, 2023.

[36] See https://blog.getbyrd.com/en/amazon-prime-eligibility-update.

Figure A.2: Amazon Communication with Sellers

Update to Prime eligibility criteria starting on June 21, 2023

Hello,

On June 21, 2023 our Prime eligibility criteria will be updated for all sellers in our Germany, France, Spain, Netherlands, Poland, Sweden, and Belgium stores following the agreement reached with the European Commission:

https://www.aboutamazon.eu/news/policy/amazons-statement-on-the-commitments-agreed-with-the-european-commission

Our Prime eligibility criteria and Prime badge criteria will be applied equally to offers from all sellers across the various fulfilment channels (Fulfilled by Amazon or Seller-Fulfilled) and Amazon retail, and are based on indicators of the experience that customers expect from Amazon Prime.

For an offer to be Prime-eligible, it needs to (1) be available nationwide, (2) offer free shipping, and (3) offer free returns for Prime members (with limited exceptions on product weight and cross-border shipments). To be eligible for Prime, Sellers must meet the below requirements on an ongoing basis at a product tier level. Details on the product tiers and their respective thresholds can be found at Seller Prime programmes:

https://sellercentral-europe.amazon.com/gp/help/GB5JRYD45LJ66K5T

Analysis Complementary to EC's investigation, recent surveys also highlight that a significant percentage of consumers exhibit strong preferences toward platforms' recommendations. For instance, approximately 98% of daily customers prefer Amazon recommendations.[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)) Motivated by the observations, I assume buyers highly trust Amazon and consider solely sellers recommended by the platform.[38]

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. As illustrated in the institutional background of the EC's regulation, I expect the likelihood of the 3P sellers winning the Buy Box to increase following EC regulations. This may be due to the adjustments in the Prime badge standards or the Buy Box algorithm on Amazon.[39]

The timeline of the game is as follows. Firm G first determines its commission fee d for each transaction in its marketplace. Second, fringe firms and Firm G 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

[37] See https://capitalcounselor.com/amazon-statistics/

[38] A comprehensive theoretical study regarding Amazon recommendation is provided by Li (2024).

[39] Prime badge is a critical factor for sellers to win Buy Box. See https://www.sellerapp.com/blog/amazon-badges/.

sellers and make purchase decisions. Within such a setup, a seller's surplus, U_s, is endogenously determined by his profit from selling final products to buyers and a buyer's utility U_b depends on both product value and price. To ensure model tractability, I adopt the simplifying assumption that the outside options of buyers are all equal to 0.

A buyer's value over a product consists of two components. The first component, v^b, represents the observable value of ancillary products before the purchase. The second component, ε^b, captures the product value that buyers cannot assess until they complete their purchase. For instance, it is challenging for buyers to estimate the return experience or the quality of customer service from the delivery company until they finish the transaction and receive the product from Amazon. Without loss of generality, I assume that buyers's expectation of ε^b is zero before the purchase, and they only realize its value after the transaction is complete. Accordingly, a buyer derives a utility of $U_b = v_G^b + \varepsilon_G^b - p_1^f$ when purchasing from 1P sellers, and a utility of $U_b = v_C^b + \varepsilon_C^b - p_3^f$ when purchasing from 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:

$$Q_1^f = (\frac{1}{2}+k)(v_G^b + E[\varepsilon_G^b] - p_1^f) = (\frac{1}{2}+k)(v_G^b - p_1^f),$$
$$Q_3^f = (\frac{1}{2}-k)(v_C^b + E[\varepsilon_C^b] - p_3^f) = (\frac{1}{2}-k)(v_C^b - p_3^f),$$

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 $q_1^f = Q_1^f/Q_G$, and the demand for each 3P seller is $q_3^f = Q_3^f/NQ_C$. Recall that Q_G 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 $\pi_1^f = (p_1^f - d - p_G)q_1^f$, 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:

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

Accordingly, the resulting profits are equal to:

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

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 $\pi_3^f = \pi_1^f = Q_G + NQ_C$ and can be simplified as:

$$n_S = Q_G + NQ_C = \sqrt{\frac{(1+2k)(v_G^b - d - p_G)^2 + (1-2k)(v_C^b - d - p_C)^2}{8}}.$$

As the charges of commission fee and ancillary product are based on transactions, the profit of each fringe firm is equal to $\pi_C = p_C Q_3^f - L$, and the profit of Firm G is $\pi_G = p_G Q_1^f + d(Q_1^f + Q_3^f)$. 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:

$$p_G = \frac{v_G^b - 2d}{2},$$
$$p_C = \frac{v_C^b - d}{2}.$$

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

$$d = \frac{v_C^b}{2},$$
$$\pi_G = \frac{(2+4k)(v_G^b)^2 + (1-2k)(v_C^b)^2}{32}.$$

Upon simple calculations, I show that Firm G finds it profitable to practice self-preferencing only when its 1P ancillary product is not strongly disliked by buyers, i.e., $v_G^b > \sqrt{2}v_C^b/2$. 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 to be not sufficiently lower than FBM services.

Reviewing industry reports, this condition is likely to be held on Amazon: Since 2019, Amazon has been heavily investing in its one-day shipping services, setting high standards for Prime shipping.[40] 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.[41] 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, a recent report indicated that the company has gradually shifted its investment from Amazon to other companies.[42] 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 seller participation is affected by Amazon's recommendation:

$$\frac{\partial n_S}{\partial k} = \frac{16\sqrt{2}(2v_G^b + v_C^b)(2v_G^b - v_C^b)}{\sqrt{(1-2k)v_C^{b\,2} + 4(1+2k)v_C^{b\,2}}}.$$

With simple calculations, I find that seller participation increases following self-preferencing when $v_G^b > v_C^b/2$. Otherwise, it is the opposite. As for buyers, they derive a net utility of $v_G^b/4 + \varepsilon_G^b$ when transacting with 1P sellers and $v_C^b/8 + \varepsilon_C^b$ when dealing with 3P sellers. Consequently, if the quality of the 1P ancillary product is low, i.e., $v_G^b + \varepsilon_G^b < v_C^b/2 + 4\varepsilon_C^b$, self-preferencing directs buyers to products that provide lower net utility, thereby reducing overall buyer surplus. Otherwise, it is the opposite.

Combining the impact of self-preferencing on Firm G's profit and welfare, I demonstrate that, within the context of per-transaction fees and buyer steering, sellers benefit from self-preferencing given that Firm G finds it profitable to do so. For buyers, their well-being can vary depending on the realized product value of the ancillary products. In a specific scenario where there is no unobserved component in ancillary product value, i.e., $\varepsilon_G^b = \varepsilon_C^b = 0$, buyers also benefit from self-preferencing. In such a market, buyers' value over ancillary products is fully captured by sellers. As buyers' and sellers' preferences over ancillary products are highly consistent, they move in the same direction following

[40] See https://www.theguardian.com/technology/2020/jan/30/amazon-profits-surge-investment-faster-shipping
[41] See https://www.fool.com/investing/2019/06/07/fedex-just-delivered-a-blow-to-amazons-one-day-del.aspx
[42] See https://www.reuters.com/business/ups-quarterly-adjusted-profit-rises-lucrative-deliveries-2022-07-26/

self-preferencing. However, if there exists an unobserved component that buyers do not fully capture in their purchase decisions and the realized value of the 1P ancillary product is quite low, steering buyers toward low-quality products may result in a lower surplus for buyers.