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When Should E-Commerce Platforms Offer Data Services to Sellers? Data Analytics, Consumer Privacy, and Platform Competition

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Abstract

E-commerce platforms increasingly use consumer search, browsing, and transaction data to offer sellers data services for keyword optimization, product matching, and targeted marketing. These services improve matching efficiency, but the use of consumer data may heighten privacy concerns and reshape participation on both market sides. We examine when a platform should offer such services under competition. We develop a game-theoretic Hotelling model of two competing two-sided platforms with cross-side network effects, seller entry fees, heterogeneous consumer privacy sensitivity, and inherent search-matching capability. We analyze no provision, unilateral provision, and symmetric provision, and characterize platforms' equilibrium adoption decisions. The results show that offering data services does not necessarily create a competitive advantage. The provider can attract more sellers and earn more than its rival while serving fewer consumers. Such relative advantages can coexist with lower profits than when neither platform offers data services. When the privacy-sensitive segment is large, offering data services reduces the provider's profit and may benefit its non-offering rival. Moreover, unilateral provision cannot benefit both platforms simultaneously and may harm both. Symmetric provision intensifies seller entry-fee competition and lowers both platforms' profits relative to no provision. When the proportion of privacy-sensitive consumers is low, symmetric provision is the unique equilibrium and it exhibits a prisoner's dilemma; while this proportion is moderate, unilateral provision by either platform is a pure-strategy equilibrium; when it is high, neither platform offering data services is the unique equilibrium. These findings identify consumer privacy sensitivity and inherent matching capability as important boundary conditions for platform data-service and seller entry-fee strategies.

Keywords: data service; platform competition; privacy concern; two-sided market; game theory

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1. Introduction

E-commerce platforms generate and accumulate large volumes of data from consumers' searches, browsing activities, clicks, transactions, and post-purchase behavior. They can transform these records into seller-facing analytical data services that support keyword selection, product positioning, demand identification, and targeted marketing. Unlike marketing tools that directly use consumer information to target advertisements, recommendations, or prices, these data services transform consumer records into processed,

seller-facing insights that support sellers' marketing decisions. Such services help sellers improve keyword selection, product positioning, and demand targeting, thereby increasing matching efficiency and expected sales. Meanwhile, the platforms can benefit from stronger cross-side participation and greater seller-entry profit, while consumers may enjoy lower search costs and more relevant product matches.

However, since data services still involve the collection and secondary use of consumer information, these benefits may be accompanied by heightened privacy concerns. Consumers may accept information collection when it is necessary for transactions or directly improves their shopping experience, but they may respond differently when their search, browsing, and purchase records are further analyzed to support sellers' targeted marketing. Even without transferring raw data or disclosing identifiable records, such practices may be perceived as expanded monitoring and commercial use of personal information. Privacy-insensitive consumers may place greater weight on improved search and matching, whereas privacy-sensitive consumers balance these benefits against the perceived privacy cost. When the privacy cost exceeds the matching benefit, they may reduce participation or switch to a competing platform. Through cross-side network effects, declining consumer participation reduces sellers' expected market opportunities and may force the data service provider to lower its entry fee. Conversely, when matching gains dominate privacy costs, the data service provider may attract both consumers and sellers and strengthen its pricing power. Accordingly, whether a platform offers data services affects not only its own participants and profit but also inter-platform competition. Unilateral adoption of data service may differentiate the provider from its rival, whereas adoption by both platforms may intensify competition for sellers even if their market shares remain symmetric. Platform profitability therefore depends jointly on matching improvement, consumer privacy sensitivity, cross-side network effects, and competitors' adoption and pricing responses.

These opposing matching and privacy effects make the value of data-service adoption theoretically ambiguous and render the adoption decision inherently strategic. Because one platform's adoption changes consumer participation, seller opportunities, and the rival platform's pricing incentives, the profitability of data services cannot be evaluated through an isolated comparison between adoption and non-adoption. In particular, profitable unilateral adoption does not necessarily imply that unilateral adoption constitutes an equilibrium, because the competing platform may respond by introducing a comparable service. Similarly, symmetric adoption need not reproduce the no-adoption outcome, even when both platforms retain equal market shares, because it may change user utilities, seller entry fees, and platform profits.

Accordingly, we address three research questions. First, how does a platform's unilateral adoption of data services affect consumer shares, seller shares, seller entry fees, and the profits of both the adopting and non-adopting platforms? Second, how does symmetric adoption differ from the no-adoption benchmark? Third, under what conditions does each of the four adoption scenarios—NN, DN, ND, or DD—arise in equilibrium?

To answer these questions, we develop a Hotelling model in which platforms first decide whether to offer data services and then set seller entry fees, after which single-homing consumers and sellers choose a platform. The analysis yields several findings. First, symmetric adoption does not reproduce the no-adoption outcome: although both platforms retain equal market shares under full market coverage, stronger cross-side feedback intensifies competition for sellers, reduces seller entry fees and platform profits, and changes consumer and seller utilities. Second, under unilateral adoption, the provider attracts more sellers, charges a higher entry fee, and earns more profit only when its matching advantage outweighs the privacy burden transmitted through consumer participation; however, its consumer-share advantage is governed by a distinct condition because consumers expe-

rience privacy costs directly. Third, unilateral adoption cannot increase both platforms' profits relative to no adoption and may make both platforms worse off when the matching improvement is insufficient to offset heightened privacy concerns and intensified fee competition. Finally, the complete adoption game exhibits a threshold structure: as the provider's matching-driven net advantage increases, the equilibrium shifts from no adoption to unilateral adoption and then to symmetric adoption, whereas stronger consumer privacy concerns move the market toward unilateral or no adoption. The adoption game equilibria may exhibit a prisoner's dilemma in which both platforms adopt data services to avoid becoming the disadvantaged sole non-provider, even though both would earn higher profits if neither adopted.

The rest of this paper is organized as follows. Section 2 summarizes the related literature. Section 3 briefly introduces the model setting. In Section 4, the equilibrium analysis is derived. Then, Section 5 gives the comparison results and the platforms' data service adoption equilibrium. Finally, Section 6 concludes the main findings and limitation of this study.

2. Related Literature

Our research relates to three streams of literature in platform economics, information application, and consumer privacy. In particular, it builds on and contributes to the literature on the competitive strategy of two-sided platforms, the platform's information application strategy, the impact of consumer privacy concern on a data-driven platform's strategy.

2.1. The Competitive Strategy of Two-Sided Platforms

A large study explores platforms as two-sided markets in which intermediaries facilitate interactions between distinct user groups and internalize cross-side network externalities [1–5]. Seminal contributions analyze how platforms structure prices and entry fees to balance participation on both sides of the market and sustain trade. For example, Armstrong [3] examines pricing strategies under monopoly and competing platforms with single-homing or multihoming users, while Caillaud and Jullien [6] study competition between matching intermediaries and characterize equilibrium market structures. Hu and Liu [5] discuss the impact of precommitments of commission rate on the competing platforms' pricing strategy when the platforms match the service demand of demanders and providers.

Subsequent studies explore competitive outcomes in platform markets, including the possibility of market dominance. Some works predict winner-take-all dynamics driven by network effects [6–9], whereas others demonstrate that multiple platforms may coexist due to factors such as asymmetric network effects, multihoming costs, and heterogeneous user preferences [10–13]. More recent research further examines how strategic platform decisions beyond pricing shape competitive outcomes, including service quality [14], investment in integration tools [15], platform launch strategies such as piggybacking [16], and seller segmentation and organization formats [17], and buyer fairness concern [18].

While this literature primarily focuses on pricing instruments used to coordinate participation on both sides of the market, our study shifts attention to a non-price strategic dimension. Specifically, we analyze platform data services as a form of search-matching-enhancing strategy that affects seller performance while indirectly influencing buyer participation through privacy concerns. By doing so, we complement the platform competition literature by highlighting how non-pricing strategies interact with cross-side externalities in competitive environments.

2.2. The Platform's Information Application Strategy

Another relevant stream of research examines platforms as information intermediaries that shape market outcomes through search, ranking, and recommendation mechanisms. Early work on information gatekeepers shows how platforms influence consumer decisions by controlling information disclosure [19]. Building on this insight, a growing literature analyzes how platforms strategically design search results or rankings to steer consumers toward certain sellers, often in response to commission or advertising incentives [20–23].

Parallel to this line of research, several studies investigate how platforms improve matching efficiency through data and algorithms. Basu et al. [24] analyze online matching platforms' joint design of search and authentication services, showing that authentication can complement search and even be offered as a loss leader. Huang et al. [25] show that disclosing recent demand information can mitigate congestion and improve matching on online dating platforms, particularly when the disclosure highlights capacity implications. Zhong [26] examines platform search design and finds that greater match precision can reduce search frictions, although its effects on prices and platform revenue depend on seller competition and the platform's revenue model. Using a large-scale experiment at JD.com, Yang et al. [27] demonstrate that advertising-propensity data help platforms evaluate new-product quality, overcome cold-start problems, and improve organic search rankings. Wang et al. [23] develop a multi-objective hierarchical recommender that combines machine learning, consumer-behavior modeling, and optimization to balance consumer, seller, and platform objectives; its implementation at Uber Eats improved conversion, retention, and gross bookings. Collectively, these studies show that platform data and algorithms improve matching by reducing information frictions, refining rankings, and coordinating multiple market-side objectives.

Our work extends this literature by explicitly incorporating platform competition and distinguishing between inherent search-matching capabilities and data services that enhance seller decision-making. We show that when platforms already possess strong matching technologies, additional data services may intensify seller-side competition across platforms, thereby affecting entry fee competition and profit outcomes. This perspective complements recent studies highlighting the strategic consequences of information design in competitive platform markets [28–30].

2.3. The Impact of Consumer Privacy Concern on a Data-Driven Platform's Strategy

The third stream of related literature is the impact of privacy concern on a data-driven platform's strategy. A rapidly expanding literature examines the role of consumer privacy concerns in digital markets. Existing research documents how privacy sensitivity affects information disclosure, acceptance of personalized services, and platform participation [31–34]. From a platform's perspective, privacy concerns introduce a fundamental trade-off between leveraging consumer data and maintaining user engagement.

While much of this literature focuses on single-platform settings or privacy policy design, some recent studies begin to explore competitive implications. These studies show that privacy affects not only information collection but also platform differentiation, pricing, and market structure. Gal-Or et al. [35] show that heterogeneity in users' privacy concerns and advertisers' targeting preferences sustains differentiation in platform targeting capabilities, whereas greater user control reduces such differentiation and advertising fees. Gopal et al. [36] find that consent-based rules may improve user surplus but can increase third-party information sharing and, when website entry and exit are endogenous, reduce competition by driving websites from the market. Using panel data around GDPR enforcement, Johnson et al. [37] document increased concentration among web-technology vendors because websites disproportionately retained leading providers. Johnson et al. [38]

further show that competition between advertising exchanges may generate inefficiently limited data sharing, whereas consumer opt-out rights reshape exchanges' incentives to provide targeting services. Consistent with these concerns, Aridor et al. [39] find that Apple's App Tracking Transparency shifted advertising expenditure from Meta toward Google and imposed larger revenue losses on smaller e-commerce firms. Dubé et al. [40] conclude that privacy restrictions may favor large incumbents that rely less on third-party data and can more readily absorb compliance costs. However, how heterogeneous privacy-sensitive consumers jointly affect seller participation, data-service adoption, and entry-fee competition between two-sided platforms remains underexplored.

Building on these streams of research, this study makes three contributions. First, it integrates seller-facing platform data services and consumer privacy concerns within a competitive two-sided market framework, extending the literature on platform competition and privacy economics. Second, we treat privacy sensitivity as a central source of buyer heterogeneity and reveal how consumers' privacy-driven participation decisions are transmitted through cross-side network effects to seller entry, platform entry fees, adoption incentives, and profits. And our analysis highlights privacy concerns as a critical boundary condition that determines whether data services enhance or weaken platform competitiveness. Finally, by jointly examining data-service adoption and seller-side pricing under different adoption scenarios, the study characterizes platforms' equilibrium adoption strategies and shows that strategic interaction may produce a prisoner's dilemma in which both platforms adopt data services even though mutual nonadoption would generate higher profits. These findings provide a unified explanation of the competitive consequences of platform data services and offer theoretical guidance for designing data-service and entry-fee strategies.

3. Model Setting

This paper considers a duopoly market consisting of two competing e-commerce platforms, denoted as Platform A and Platform B. Each platform operates as a two-sided market, connecting sellers on one side and consumers on the other. Both sellers and consumers are classified as single-home, meaning that each participant joins only one platform. We assume full market coverage, with outside options sufficiently unattractive that all sellers and consumers choose one of the two platforms. Consequently, changes in platform participation refer to the reallocation of participants between platforms rather than changes in the total market size.

On the seller side, the total mass of potential sellers is normalized to one and uniformly distributed along the unit interval $[0, 1]$. Sellers choose whether to join Platform A or B by comparing the perceived utility from Platform i, which is determined by platform entry fee and their expected sales performance on each platform. On the consumer side, the total mass of consumers is also normalized to one and uniformly distributed along the unit interval $[0, 1]$. Consumers are assumed to search for a product immediately upon logging into a platform and to purchase conditional on a successful match. This assumption abstracts from delayed purchasing and repeated search while retaining the possibility of unsuccessful matching. During the processes of platform access and product purchase, platforms can collect various types of consumer information, including browsing behavior, payment records, and purchase histories. According to Bellman et al. [41], due to consumers' limited control over the disclosure and use of their personal information, such data collection generates privacy concerns among consumers. To simplify the analysis, the value generated by a successful match for a seller and a consumer is normalized to one. And product pricing is not a strategic decision in the model.

Platform i ($i = A,B$) generates profit by charging sellers a one-time platform entry fee. Platform profit π_i is determined by the entry fee f_i charged and the number of sellers n_i

in platform i. Accordingly, each platform maximizes its profit from sellers' entry fees, by balancing the entry fee against the resulting seller participation. Meanwhile, the platforms provide free service to consumers. The number of sellers on Platform i n_i is influenced by two key factors: (i) the joining cost, represented by the platform's entry fee, and (ii) the potential consumers m_i, which is affected by platform network externalities, consumers' utility from product purchases, and consumers' utility associated with privacy information disclosure. Consumer participation affects sellers' expected sales opportunities, while seller participation affects consumers' opportunities to find suitable products, generating cross-side network effects.

In practice, the matching process on the platform proceeds as follows. First, sellers assign keywords to describe the attributes of their products. Second, consumers input search keywords based on their preferences or needs. Finally, the platform matches consumer search keywords with sellers' product keywords and displays the relevant products. Since the keywords of consumers and sellers may not perfectly match, we define the probability of successfully matching a consumer's search intent with a relevant product as the platform's inherent search-matching rate.

When platforms do not provide data services, Platform A and B are assumed to have identical inherent search-matching rates, denoted by $e \in [0, 1]$. Due to information asymmetry, however, discrepancies may exist between the keywords set by sellers and those searched by consumers. Platforms can utilize collected consumer information to analyze search behaviors and provide sellers with anonymized data analytics results. Such data services assist sellers in optimizing product keyword settings, thereby improving the effectiveness of keyword-based matching. For example, Taobao's "Business Advisor" tool offers features such as "Topic Keywords" and "Trending/New Keywords," enabling sellers to refine their keyword strategies based on aggregated user data. These services provide processed, seller-facing insights rather than directly transferring identifiable consumer records or raw data to sellers. Their immediate function is to support sellers' marketing decisions, distinguishing them from tools through which the platform directly targets advertisements, recommendations, or prices to individual consumers.

In this paper, the proportional improvement in search-matching effectiveness resulting from platform data services is $d_m > 0$, which is defined as the matching-improvement coefficient. Thus, the effective matching rate is e without data services and $(1 + d_m)e \leq 1$ with data services. All participating sellers on an adopting platform have access to the service, and its matching improvement is represented at the platform level. To focus on the competitive effects of data service, we assume no separate data-service charge and normalize the related cost to zero.

Following the related literature [31,42], this paper assumes that the consumer market consists of two types of consumers. The first type is privacy-sensitive consumers, who evaluate platform participation by weighing matching benefits against the perceived privacy costs associated with information collection and use. The proportion of privacy-sensitive consumers is $g \in [0, 1]$. The second type is privacy-insensitive consumers, who do not attach importance to information privacy and choose platforms solely based on the utility derived from product consumption and platform differentiation. Correspondingly, the proportion of privacy-insensitive consumers is $1 - g$. We adopt different subscripts "s" and "h" to distinguish privacy-sensitive and privacy-insensitive consumers, respectively. Correspondingly, the potential consumer demand $m_i = gm_{si} + (1 - g)m_{hi}$. Here, m_{si} and m_{hi} denote the proportions of the respective consumer types choosing Platform i. Privacy type is independent of consumer preference over the platforms which is represented by the Hotelling location, and consumers within each type are uniformly distributed along $[0, 1]$.

For privacy-sensitive consumers, the disclosure of personal information during the purchasing process generates privacy costs by the increasing privacy concerns, and the provision of data services by platforms further amplifies their privacy concerns. Specifically, when a platform offers data services, the level of privacy concern perceived by privacy-sensitive consumers is jointly determined by their initial privacy concern when they join in the platform and the additional concern associated with the secondary commercial use in the platforms' data services. This perceived privacy cost can arise even when sellers receive only anonymized or aggregated analytical outputs; it does not require the disclosure of identifiable records or an actual data breach. We assume that, when a platform does not provide data services, the privacy concern level of privacy-sensitive consumers is denoted by β. When the platform provides data services, their privacy concern level increases to $(1 + d_p)\beta$, where $d_p \geq 0$ is privacy intensification coefficient, capturing the additional perceived privacy cost associated with data-service provision. For privacy-insensitive consumers, the privacy disutility associated with information collection and use is normalized to zero.

Then, we describe the competition between the platforms. We adopt a classic Hotelling linear city framework to model platform choice by sellers and consumers between Platform A and B. Platform A and B are exogenously located at the two endpoints, 0 and 1, respectively. Choosing a platform entails opportunity costs for both sellers and consumers, which capture the disutility arising from platform differentiation. For simplicity, the unit opportunity cost coefficients for both sellers and consumers are assumed to be identical and denoted by t. For a seller or consumer located at $x \in [0, 1]$, which represents his preference over their ideal platform, his opportunity cost is tx. The perceived utility obtained by a representative seller from joining Platform i is U_i. The utility of a privacy-sensitive consumer when purchasing from Platform i is u_{si}, and the utility of a privacy-insensitive consumer when purchasing from Platform i is u_{hi}. Throughout the analysis, subscripts "s" and "h" consistently identify privacy-sensitive and privacy-insensitive consumers, respectively. To focus on the existence of interior equilibria, we assume $t > \max[(1 + d_m)e, e + \beta d_p]$. This condition ensures that both consumer types retain interior platform shares for every possible seller allocation. It therefore rules out profitable fee deviations that operate by moving an entire consumer type to one platform.

The timing sequence is given as follows. In the 1st stage, the platforms simultaneously choose whether to provide data services. In the 2nd stage, the platforms set their seller entry fees after observing both platforms' data service decisions. In the 3rd stage, sellers and consumers choose their platform-joining decisions. Finally, the platforms generate profits.

4. Equilibrium Analysis

Based on the provision of data service, we consider four different competitive scenarios. In the rest of our analysis, superscript "NN" denotes that neither platform provides data services, "DN" denotes provision by Platform A only, "ND" denotes provision by Platform B only, and "DD" denotes provision by both platforms. Since Platform A and B are symmetric, the equilibrium under ND follows from that under DN by interchanging platform labels. Therefore, we analyze the equilibrium under NN, DN and DD by backward induction.

4.1. Equilibrium When Neither Platform Provides Data Services

We firstly examine the equilibrium outcomes when neither platform provides data services. Sellers choose to join Platform A or B by maximizing their perceived utility. Based

on the classic Hotelling linear city framework, the seller's perceived utilities by joining Platform A or B are given as follows:

$$U_A^{NN} = em_A^{NN} - f_A^{NN} - tx_s^{NN}$$

$$U_B^{NN} = em_B^{NN} - f_B^{NN} - t(1 - x_s^{NN})$$

Let $U_A^{NN} = U_B^{NN}$, we derive the response functions of the sellers joining Platform A and B are:

$$n_A^{NN}(m_A^{NN}, m_B^{NN}, f_A^{NN}, f_B^{NN}) = \frac{1}{2} + \frac{e(m_A^{NN} - m_B^{NN}) - f_A^{NN} + f_B^{NN}}{2t}$$

$$n_B^{NN}(m_A^{NN}, m_B^{NN}, f_A^{NN}, f_B^{NN}) = \frac{1}{2} - \frac{e(m_A^{NN} - m_B^{NN}) - f_A^{NN} + f_B^{NN}}{2t}$$

Since there are n_i^{NN} sellers on Platform i, the inherent search-matching rate is e, the perceived utilities of privacy-sensitive consumer from Platform A and B are:

$$u_{sA}^{NN} = en_A^{NN} - \beta - tx_s^{NN}$$

$$u_{sB}^{NN} = en_B^{NN} - \beta - t(1 - x_s^{NN})$$

Similarly, the perceived utilities of privacy-insensitive consumer from Platform A and B are:

$$u_{hA}^{NN} = en_A^{NN} - tx_h^{NN}$$

$$u_{hB}^{NN} = en_B^{NN} - t(1 - x_h^{NN})$$

By solving the equations $u_{sA}^{NN} = u_{sB}^{NN}$ and $u_{hA}^{NN} = u_{hB}^{NN}$, we derive the response functions of potential demands of Platform A and B are:

$$m_A^{NN}(n_A^{NN}, n_B^{NN}) = gm_{sA}^{NN} + (1-g)m_{hA}^{NN} = \frac{1}{2} + \frac{(n_A^{NN} - n_B^{NN})e}{2t}$$

$$m_B^{NN}(n_A^{NN}, n_B^{NN}) = gm_{sB}^{NN} + (1-g)m_{hB}^{NN} = \frac{1}{2} - \frac{(n_A^{NN} - n_B^{NN})e}{2t}$$

Substitute the response functions of potential demands into the response functions of sellers joining the platforms, and we solve the following equation set:

$$\begin{cases} n_A^{NN} = \frac{1}{2} + \frac{(n_A^{NN} - n_B^{NN})e^2 - t(f_A^{NN} - f_B^{NN})}{2t^2} \\ n_B^{NN} = \frac{1}{2} - \frac{(n_A^{NN} - n_B^{NN})e^2 - t(f_A^{NN} - f_B^{NN})}{2t^2} \end{cases}$$

Simplify the above equation set, we have the response functions of sellers joining the platforms as

$$\begin{cases} n_A^{NN}(f_A^{NN}, f_B^{NN}) = \frac{1}{2} - \frac{t(f_A^{NN} - f_B^{NN})}{2(t^2 - e^2)} \\ n_B^{NN}(f_A^{NN}, f_B^{NN}) = \frac{1}{2} + \frac{t(f_A^{NN} - f_B^{NN})}{2(t^2 - e^2)} \end{cases}$$

Then, the profit that Platform i generates is:

$$\pi_i^{NN}(f_A^{NN}, f_B^{NN}) = n_i^{NN} f_i^{NN}$$

With the first-order-condition, we maximize Platform i's profit of entry fee f_i^{NN}, and have the optimal entry fee is:

$$f_i^{NN*} = t - \frac{e^2}{t}$$

In equilibrium, the potential demand and sellers on Platform i are $\frac{1}{2}$. Substitute the equilibrium entry fee and sellers on Platform i into the platform's profit, we have

$$\pi_i^{NN*} = \frac{1}{2}\left(t - \frac{e^2}{t}\right)$$

4.2. Equilibrium When Only Platform A Provides Data Services

Then, we discuss the equilibrium decisions of the sellers, consumers and platforms. Since Platform A provides data services, while Platform B does not provide data services, the search-matching rate in Platform A will increase from e to $(1 + d_m)e$, and it in Platform B remains e. Similar with the analysis in Section 4.1, we firstly show the seller's perceived utilities by joining Platform A or B.

$$U_A^{DN} = (1 + d_m)em_A^{DN} - f_A^{DN} - tx_s^{DN}$$

$$U_B^{DN} = em_B^{DN} - f_B^{DN} - t(1 - x_s^{DN})$$

Let $U_A^{DN} = U_B^{DN}$, we derive the response functions of sellers joining Platform A and B are:

$$n_A^{DN}(m_A^{DN}, m_B^{DN}, f_A^{DN}, f_B^{DN}) = \frac{1}{2} + \frac{(1 + d_m)em_A^{DN} - em_B^{DN} - f_A^{DN} + f_B^{DN}}{2t}$$

$$n_B^{DN}(m_A^{DN}, m_B^{DN}, f_A^{DN}, f_B^{DN}) = \frac{1}{2} - \frac{(1 + d_m)em_A^{DN} - em_B^{DN} - f_A^{DN} + f_B^{DN}}{2t}$$

Following the assumption of consumers' response to their perceived secondary use of personal information arising from the search-matching improvement, when only Platform A provides data services, the perceived utilities of privacy-sensitive consumer from Platform A and B are:

$$u_{sA}^{DN} = (1 + d_m)en_A^{DN} - \left(1 + d_p\right)\beta - tx_s^{DN}$$

$$u_{sB}^{DN} = en_B^{DN} - \beta - t(1 - x_s^{DN})$$

Similarly, the perceived utilities of privacy-insensitive consumer from Platform A and B are:

$$u_{hA}^{DN} = (1 + d_m)en_A^{DN} - tx_h^{DN}$$

$$u_{hB}^{DN} = en_B^{DN} - t(1 - x_h^{DN})$$

By solving the equations $u_{sA}^{DN} = u_{sB}^{DN}$ and $u_{hA}^{DN} = u_{hB}^{DN}$, we derive the response functions of potential demands of Platform A and B are:

$$m_A^{DN}(n_A^{DN}, n_B^{DN}) = gm_{sA}^{DN} + (1 - g)m_{hA}^{DN} = \frac{1}{2} + \frac{(n_A^{DN} - n_B^{DN})e + ed_m n_A^{DN} - \beta d_p g}{2t}$$

$$m_B^{DN}(n_A^{DN}, n_B^{DN}) = gm_{sB}^{DN} + (1 - g)m_{hB}^{DN} = \frac{1}{2} - \frac{(n_A^{DN} - n_B^{DN})e + ed_m n_A^{DN} - \beta d_p g}{2t}$$

Substitute the response functions of potential demands into the response functions of sellers joining the platforms, and we solve the following equation set:

$$\begin{cases} n_A^{DN} = \frac{1}{2} + \frac{\Lambda + e^2(2+d_m)^2(n_A^{DN} - n_B^{DN}) - 4t(f_A^{DN} - f_B^{DN})}{8t^2} \\ n_B^{DN} = \frac{1}{2} - \frac{\Lambda + e^2(2+d_m)^2(n_A^{DN} - n_B^{DN}) - 4t(f_A^{DN} - f_B^{DN})}{8t^2} \end{cases}$$

where $\Lambda = ed_m[2t + e(2 + d_m)] - 2e(2 + d_m)g\beta d_p$. Solving the above equation set, we have the response functions of seller participation as

$$\begin{cases} n_A^{DN}(f_A^{DN}, f_B^{DN}) = \frac{1}{2} + \frac{\Lambda - 4t(f_A^{DN} - f_B^{DN})}{2\left[4t^2 - e^2(2+d_m)^2\right]} \\ n_B^{DN}(f_A^{DN}, f_B^{DN}) = \frac{1}{2} - \frac{\Lambda - 4t(f_A^{DN} - f_B^{DN})}{2\left[4t^2 - e^2(2+d_m)^2\right]} \end{cases}$$

Then, the profit that Platform i generates is:

$$\pi_i^{DN}(f_A^{DN}, f_B^{DN}) = n_i^{DN} f_i^{DN}$$

With the first-order-condition, we maximize Platform i's profit of entry fee f_i^{DN}, and have the optimal entry fee is:

$$f_A^{DN*} = \frac{3\left[4t^2 - e^2(2+d_m)^2\right] + \Lambda}{12t}$$

$$f_B^{DN*} = \frac{3\left[4t^2 - e^2(2+d_m)^2\right] - \Lambda}{12t}$$

Substitute the equilibrium entry fee to the response function of potential demand and sellers on Platform i, we have the equilibrium potential demands and sellers on Platform i as follows.

$$m_A^{DN*} = \frac{1}{2} + \frac{3\left(ed_m - 2g\beta d_p\right)\left[4t^2 - e^2(2+d_m)^2\right] + e(2+d_m)\Lambda}{12t\left[4t^2 - e^2(2+d_m)^2\right]}$$

$$m_B^{DN*} = \frac{1}{2} - \frac{3\left(ed_m - 2g\beta d_p\right)\left[4t^2 - e^2(2+d_m)^2\right] + e(2+d_m)\Lambda}{12t\left[4t^2 - e^2(2+d_m)^2\right]}$$

$$n_A^{DN*} = \frac{1}{2} + \frac{\Lambda}{6\left[4t^2 - e^2(2+d_m)^2\right]}$$

$$n_B^{DN*} = \frac{1}{2} - \frac{\Lambda}{6\left[4t^2 - e^2(2+d_m)^2\right]}$$

Then, the equilibrium profits of Platform A and B are:

$$\pi_A^{DN*} = \frac{\left\{3\left[4t^2 - e^2(2+d_m)^2\right] + \Lambda\right\}^2}{72t\left[4t^2 - e^2(2+d_m)^2\right]}$$

$$\pi_B^{DN*} = \frac{\left\{3\left[4t^2 - e^2(2+d_m)^2\right] - \Lambda\right\}^2}{72t\left[4t^2 - e^2(2+d_m)^2\right]}$$

4.3. Equilibrium When Both Platforms Provide Data Services

We further analyze the equilibrium when both platforms provide data services. The search-matching rate in both platforms will increase from e to $(1+d_m)e$, and privacy-sensitive consumers incur the common privacy disutility $\beta(1+d_p)$. Similar with the analysis in Section 4.1, we firstly show the seller's perceived utilities by joining Platform A or B as follows.

$$U_A^{DD} = (1+d_m)em_A^{DD} - f_A^{DD} - tx_s^{DD}$$

$$U_B^{DD} = (1+d_m)em_B^{DD} - f_B^{DD} - t(1-x_s^{DD})$$

Let $U_A^{DD} = U_B^{DD}$, we derive the response functions of the sellers joining Platform A and B are:

$$n_A^{DD}(m_A^{DD}, m_B^{DD}, f_A^{DD}, f_B^{DD}) = \frac{1}{2} + \frac{e(1+d_m)(m_A^{DD} - m_B^{DD}) - f_A^{DD} + f_B^{DD}}{2t}$$

$$n_B^{DD}(m_A^{DD}, m_B^{DD}, f_A^{DD}, f_B^{DD}) = \frac{1}{2} - \frac{e(1+d_m)(m_A^{DD} - m_B^{DD}) - f_A^{DD} + f_B^{DD}}{2t}$$

Following the assumption of consumers' response to their perceived secondary use of personal information arising from the search-matching improvement, when both platforms provide data services, the perceived utilities of privacy-sensitive consumer from Platform A and B are:

$$u_{sA}^{DD} = e(1+d_m)n_A^{DD} - \beta\left(1+d_p\right) - tx_s^{DD}$$

$$u_{sB}^{DD} = e(1+d_m)n_B^{DD} - \beta\left(1+d_p\right) - t(1-x_s^{DD})$$

Similarly, the perceived utilities of privacy-insensitive consumer from Platform A and B are:

$$u_{hA}^{DD} = e(1+d_m)n_A^{DD} - tx_h^{DD}$$
$$u_{hB}^{DD} = e(1+d_m)n_B^{DD} - t(1-x_h^{DD})$$

By solving the equations $u_{sA}^{DD} = u_{sB}^{DD}$ and $u_{hA}^{DD} = u_{hB}^{DD}$, we derive the response functions of potential demands of Platform A and B are:

$$m_A^{DD}(n_A^{DD}, n_B^{DD}) = gm_{sA}^{DD} + (1-g)m_{hA}^{DD} = \frac{1}{2} + \frac{(1+d_m)e(n_A^{DD} - n_B^{DD})}{2t}$$

$$m_B^{DD}(n_A^{DD}, n_B^{DD}) = gm_{sB}^{DD} + (1-g)m_{hB}^{DD} = \frac{1}{2} - \frac{(1+d_m)e(n_A^{DD} - n_B^{DD})}{2t}$$

Substitute the response functions of potential demands into the response functions of sellers joining the platforms, and we solve the following equation set:

$$\begin{cases} n_A^{DD} = \frac{1}{2} + \frac{e^2(1+d_m)^2(n_A^{DD}-n_B^{DD}) - t(f_A^{DD}-f_B^{DD})}{2t^2} \\ n_B^{DD} = \frac{1}{2} - \frac{e^2(1+d_m)^2(n_A^{DD}-n_B^{DD}) - t(f_A^{DD}-f_B^{DD})}{2t^2} \end{cases}$$

Solving the above equation set, we have the response functions of seller participation as

$$n_A^{DD}(f_A^{DD}, f_B^{DD}) = \frac{1}{2} - \frac{t(f_A^{DD}-f_B^{DD})}{2\left[t^2 - e^2(1+d_m)^2\right]}$$
$$n_B^{DD}(f_A^{DD}, f_B^{DD}) = \frac{1}{2} + \frac{t(f_A^{DD}-f_B^{DD})}{2\left[t^2 - e^2(1+d_m)^2\right]}$$

Then, the profit that Platform i generates is:

$$\pi_i^{DD}(f_A^{DD}, f_B^{DD}) = n_i^{DD} f_i^{DD}$$

With first-order-condition, we maximize Platform i's profit of entry fee f_i^{DD}, and have the optimal entry fee is:

$$f_i^{DD*} = t - \frac{e^2(1+d_m)^2}{t}$$

Substituting the equilibrium fees into the participation functions gives the equilibrium seller and consumer shares,

$$n_i^{DD*} = m_i^{DD*} = \frac{1}{2}$$

Each consumer type also divides equally between platforms. Substituting the equilibrium fee and seller share into the profit function gives

$$\pi_i^{DD*} = \frac{t^2 - e^2(1+d_m)^2}{2t}$$

5. Comparison Results and Adoption Equilibrium

In this section, we first compare the equilibrium outcomes of Platform A and B when only Platform A provides data service, it can reveal whether data service help platform establish competitive advantages over its competitor. Then, we compare the equilibrium outcomes under the four competitive scenarios, and derive the platforms' equilibrium adoption strategy of data service.

5.1. Does Data Service Make Platform A Better than Platform B?

Based on the above equilibrium outcomes when only Platform A provides data services, we compare the potential demands and sellers on the platforms, the entry fees and the profits of the platforms.

Corollary 1 (Comparison result of equilibrium entry fee). *When only Platform A provides data service, if* $g \geq \frac{d_m[2t + e(2 + d_m)]}{2(2 + d_m)\beta d_p}$, $f_A^{DN*} \leq f_B^{DN*}$; *otherwise,* $f_A^{DN*} > f_B^{DN*}$.

Corollary 1 shows that offering data services does not necessarily enable a platform to charge a higher seller entry fee than its competitor. When the proportion of privacy-sensitive consumers is below a threshold, Platform A charges a higher equilibrium entry fee than Platform B; otherwise, Platform A charges a lower equilibrium entry fee than Platform B. This result reflects the interplay between consumers' privacy–benefit trade-offs and cross-side network effects in two-sided markets.

By improving matching efficiency, data services increase sellers' expected transaction returns and increase their willingness to pay for platform access. However, the secondary use of consumer information also generates perceived privacy costs, potentially inducing privacy-sensitive consumers to switch to Platform B. The resulting loss of consumers reduces sellers' expected market opportunities on Platform A and weakens its ability to charge a higher seller entry fee than Platform B. As the proportion of privacy-sensitive consumers increases, privacy induced consumer switching weakens sellers' willingness to pay for access to Platform A. Once this proportion exceeds the threshold, Platform A's equilibrium seller entry fee becomes lower than Platform B's, reversing the fee ordering observed below the threshold.

Hence, in practice, platforms should coordinate data-service provision with seller pricing rather than assume that improved matching automatically creates room for higher fees. Pricing decisions should account jointly for the composition of consumer privacy preferences, the platform's inherent matching capability, and the improvement generated by data services. In particular, platforms serving privacy-sensitive markets should incorporate the indirect consequences of consumer switching for seller participation into their pricing strategy.

Corollary 2 (Comparison result of consumer demand). *When only Platform A provides data services, if* $g \geq \frac{ed_m[3t - e(2 + d_m)][2t + e(2 + d_m)]}{2\beta d_p\left[6t^2 - e^2(2 + d_m)^2\right]}$, $m_A^{DN*} \leq m_B^{DN*}$; *otherwise,* $m_A^{DN*} > m_B^{DN*}$.

Corollary 2 shows that Platform A attracts more consumers than Platform B when the proportion of privacy-sensitive consumers is below a threshold, but fewer consumers when this proportion exceeds the threshold.

This result follows from consumers' trade-off between matching benefits and privacy costs, together with cross-side network effects. Data services improve matching between consumers and sellers, increasing the benefits consumers obtain from joining Platform A. However, the secondary use of consumer information imposes additional perceived privacy costs on privacy-sensitive consumers. As their proportion increases, these costs affect a larger share of the market and shift consumer demand toward Platform B. Consumer choices also depend on seller participation. More sellers increase consumers' expected matching benefits, while consumer switching reduces sellers' expected transaction opportunities on Platform A and can weaken their incentives to join. Equilibrium entry fees influence seller participation and therefore also affect consumer demand.

For managers, the result indicates that improved matching alone is insufficient to ensure a larger consumer base. Platforms should assess the proportion of privacy-sensitive

consumers and the additional privacy costs associated with data services before adoption. They should also distinguish consumer attraction from seller pricing power, because the ability to charge sellers a higher entry fee does not necessarily imply that the platform attracts more consumers.

Corollary 3 (Comparison result of sellers). *When only Platform A provides data services, if* $g \geq \frac{d_m[2t + e(2 + d_m)]}{2(2 + d_m)\beta d_p}$, $n_A^{DN*} \leq n_B^{DN*}$; *otherwise,* $n_A^{DN*} > n_B^{DN*}$.

Corollary 3 shows that Platform A attracts more sellers than Platform B when the proportion of privacy-sensitive consumers is below a threshold, but fewer sellers when this proportion exceeds the threshold.

Sellers choose between platforms by weighing expected transaction returns against entry fees. Data services improve matching efficiency and can therefore make Platform A more attractive to sellers. However, the additional privacy costs associated with these services may induce privacy-sensitive consumers to choose Platform B. As the proportion of these consumers increases, consumer demand shifts toward Platform B, reducing sellers' expected transaction opportunities on Platform A. Consumer privacy concerns thus affect seller participation indirectly through cross-side network effects, even though sellers benefit from the analytical capabilities of data services. Combined with Corollary 1, this result shows that Platform A attracts more sellers while charging a higher entry fee below the threshold. Above that threshold, Platform A attracts fewer sellers despite charging a lower entry fee. Because the lower entry fee is insufficient to offset the reduction in sellers' expected transaction returns.

Managerially, platforms should assess seller-facing data services together with their consequences for consumer demand. Improved matching does not guarantee greater seller participation when privacy concerns reduce consumer demand. Platforms should therefore incorporate matching improvements, the proportion of privacy-sensitive consumers, and the resulting consumer allocation into seller pricing and recruitment decisions.

Based on the above comparisons, we derive the comparison result of the competitive platforms' equilibrium profits.

Proposition 1. *When only Platform A provides data services, if* $g \geq \frac{d_m[2t + e(2 + d_m)]}{2(2 + d_m)\beta d_p}$, $\pi_A^{DN*} \leq \pi_B^{DN*}$, *otherwise,* $\pi_A^{DN*} > \pi_B^{DN*}$.

Proposition 1 shows that Platform A earns a higher equilibrium profit than Platform B when the proportion of privacy-sensitive consumers is below a threshold; otherwise, Platform A earns less than Platform B.

This comparison follows from the joint effects of data services on seller entry fees and seller participation. Below the threshold, improved matching increases sellers' expected transaction returns sufficiently for Platform A to attract more sellers while charging a higher entry fee. The higher fee and larger seller base jointly generate higher profits than those of Platform B. When the proportion of privacy-sensitive consumers is above the threshold, privacy concerns shift consumer demand toward Platform B and reduce sellers' expected transaction opportunities on Platform A. Platform A then charges a lower entry fee but still attracts fewer sellers, resulting in lower profits than Platform B. Thus, privacy concerns affect platform profitability through both the entry fee paid by sellers and the number of sellers paying the entry fee. The threshold increases with the platform's inherent matching capability and the matching improvement generated by data services, but decreases with privacy intensification. Managerially, platforms should assess whether matching improvements can sustain seller participation and entry fees given consumers' privacy preferences.

Profit forecasts should incorporate consumer switching and its consequences for seller participation alongside equilibrium pricing responses.

5.2. When Should Platforms Provide Data Service?

We compare the equilibrium outcomes across NN, DN, and DD. The comparisons distinguish the effect of introducing a service when the rival does not provide it from the effect of joining a rival that already provides it. The ND results follow by interchanging platform labels.

Corollary 4 (Comparison result of equilibrium entry fee). *(i) If* $g < \frac{d_m[t - e(5 + 4d_m)]}{(2 + d_m)\beta d_p}$, $f_A^{DN*} > f_A^{NN*} > f_A^{DD*}, f_B^{NN*} > f_B^{DD*} > f_B^{DN*}$; *(ii) If* $\frac{d_m[t - e(5 + 4d_m)]}{(2 + d_m)\beta d_p} < g < \frac{d_m[t - e(5 + d_m)]}{(2 + d_m)\beta d_p}$, $f_A^{DN*} > f_A^{NN*} > f_A^{DD*}, f_B^{NN*} > f_B^{DN*} > f_B^{DD*}$; *(iii) If* $\frac{d_m[t - e(5 + d_m)]}{(2 + d_m)\beta d_p} < g < \frac{d_m[t + e(7 + 2d_m)]}{(2 + d_m)\beta d_p}$, $f_A^{NN*} > f_A^{DN*} > f_A^{DD*}, f_B^{NN*} > f_B^{DN*} > f_B^{DD*}$; *(iv) If* $\frac{d_m[t + e(7 + 2d_m)]}{(2 + d_m)\beta d_p} < g < \frac{d_m[t + e(7 + 5d_m)]}{(2 + d_m)\beta d_p}$, $f_A^{NN*} > f_A^{DN*} > f_A^{DD*}, f_B^{DN*} > f_B^{NN*} > f_B^{DD*}$; *(v) If* $g > \frac{d_m[t + e(7 + 5d_m)]}{(2 + d_m)\beta d_p}$, $f_A^{NN*} > f_A^{DD*} > f_A^{DN*}, f_B^{DN*} > f_B^{NN*} > f_B^{DD*}$.

Corollary 4 shows the impact of data services on entry fee comparison results, it depends jointly on consumer privacy composition and the competitor's adoption decision. Symmetric adoption always produces lower entry fees than no adoption. Under unilateral adoption, an increase in the proportion of privacy-sensitive consumers lowers Platform A's equilibrium entry fee and raises Platform B's. Platform A's entry fee can therefore rank above NN, between NN and DD, or below DD, while Platform B's entry fee comparison result exhibits the opposite progression. These results reflect changes in sellers' expected transaction opportunities and the intensity of platform competition.

When privacy-sensitive consumers are relatively few, Platform A's matching improvement increases sellers' willingness to pay for access. As their proportion increases, consumer switching toward Platform B reduces sellers' expected transaction returns on Platform A and increases those on Platform B. Platform A consequently lowers its entry fee, while Platform B raises its fee. Under symmetric adoption, both platforms provide improved matching, so neither retains an exclusive service advantage. Stronger cross-side network effects make seller participation more responsive to fee differences, intensifying competition and lowering both platforms' entry fees relative to NN.

Hence, platforms should incorporate consumer privacy composition and competitors' adoption decisions into seller pricing strategy. Platforms should therefore assess how matching improvements affect both sellers' willingness to pay and the competitive pressure on entry fees when developing data-service strategies.

Corollary 5 (Comparison result of consumer demand). *If* $g \leq \frac{ed_m[3t - e(2 + d_m)][2t + e(2 + d_m)]}{2\beta d_p\left[6t^2 - e^2(2 + d_m)^2\right]}$, $m_A^{DN*} \geq m_A^{NN*} = m_A^{DD*}, m_B^{DN*} \leq m_B^{NN*} = m_B^{DD*}$; *otherwise,* $m_A^{DN*} \leq m_A^{NN*} = m_A^{DD*}, m_B^{DN*} \geq m_B^{NN*} = m_B^{DD*}$.

Corollary 5 shows that under DN, Platform A attracts more consumers than under either symmetric profile when the proportion of privacy-sensitive consumers is below a threshold, while Platform B attracts fewer. Above the threshold, Platform A attracts fewer consumers and Platform B attracts more.

These results reflect consumers' evaluation of matching benefits and privacy costs, together with the influence of seller participation on platform attractiveness. With unilateral provision, improved matching favors Platform A, whereas the additional privacy burden favors Platform B. Increasing the proportion of privacy-sensitive consumers shifts the equi-

librium allocation toward Platform B. Under DD, matching improvements and privacy costs apply symmetrically, eliminating the differences that drive consumer reallocation under DN. Full market coverage therefore produces equal shares despite changes in consumers' utility levels.

Hence, a consumer-share advantage from unilateral provision depends on the competitor's subsequent adoption decision. When privacy-sensitive consumers are relatively few, Platform B's adoption restores its share to one-half. When they are sufficiently numerous, adopting instead removes Platform B's privacy advantage and reduces its share to one-half. Platforms should therefore assess whether following a competitor's adoption strengthens or weakens their appeal to consumers. They should also distinguish improvements in matching efficiency from changes in market share, because symmetric provision can improve matching without attracting a larger share of consumers to either platform.

Corollary 6 (Comparison result of sellers). *If* $g \leq \frac{d_m[2t + e(2 + d_m)]}{2(2 + d_m)\beta d_p}$, $n_A^{DN*} \geq n_A^{NN*} = n_A^{DD*}$, $n_B^{DN*} \leq n_B^{NN*} = n_B^{DD*}$; *otherwise,* $n_A^{DN*} \leq n_A^{NN*} = n_A^{DD*}$, $n_B^{DN*} \geq n_B^{NN*} = n_B^{DD*}$.

Corollary 6 shows that when the proportion of privacy-sensitive consumers is below a threshold, Platform A attracts more sellers than under NN or DD, while Platform B attracts fewer. Above the threshold, Platform A attracts fewer sellers than under NN or DD, while Platform B attracts more.

The result arises because sellers evaluate expected transaction returns against entry fees. Under DN, Platform A's matching improvement raises the return from reaching consumers and can support a larger seller share. However, privacy concerns shift consumer demand toward Platform B, reducing sellers' expected transaction opportunities on Platform A. As privacy-sensitive consumers become more prevalent, this indirect loss can outweigh the matching improvement despite Platform A's fee adjustment. Consumer privacy concerns therefore influence seller allocation through cross-side network effects. Comparing Corollaries 5 and 6 also shows that Platform A can attract more sellers while serving fewer consumers, because better matching can compensate sellers for a smaller consumer base. Under DD, symmetric service provision removes the differences responsible for seller reallocation. Equal shares under NN and DD nevertheless coexist with different seller benefits, since DD provides improved matching and lower entry fees.

For managers, platforms should assess seller-facing data services using both matching effectiveness and the consumer demand available to sellers. Seller pricing and recruitment decisions should incorporate consumers' privacy responses, and unchanged seller shares after symmetric adoption should not be interpreted as evidence that sellers receive no additional benefits.

Based on Corollary 6, although NN and DD have identical seller shares, seller utilities differ. At a fixed location, the equilibrium utility gain from symmetric provision is

$$U_i^{DD} - U_i^{NN} = \frac{ed_m}{2} + \frac{e^2 d_m(2 + d_m)}{t} > 0$$

Sellers benefit from both better matching and lower equilibrium entry fees. And these benefits need not translate into higher platform profits.

We further compare the equilibrium profits of the platforms under NN, DN and DD, and derive the following comparison results.

Corollary 7 (Comparison results of platforms' profits). *(i) If* $g < g_1$, $\pi_A^{DN*} > \pi_A^{NN*} > \pi_A^{DD*}$, $\pi_B^{NN*} > \pi_B^{DD*} > \pi_B^{DN*}$; *(ii) If* $g_1 < g < g_2$, $\pi_A^{DN*} > \pi_A^{NN*} > \pi_A^{DD*}$, $\pi_B^{NN*} > \pi_B^{DN*} > \pi_B^{DD*}$; *(iii) If* $g_2 < g < \frac{2d_m[2t + e(2 + d_m)]}{2\beta d_p(2 + d_m)} - g_2$, $\pi_A^{NN*} > \pi_A^{DN*} > \pi_A^{DD*}$, $\pi_B^{NN*} > \pi_B^{DN*} > \pi_B^{DD*}$; *(iv) If* $\frac{2d_m[2t + e(2 + d_m)]}{2\beta d_p(2 + d_m)} - g_2 < g < \frac{2d_m[2t + e(2 + d_m)]}{2\beta d_p(2 + d_m)} - g_1$, $\pi_A^{NN*} > \pi_A^{DN*} > \pi_A^{DD*}$, $\pi_B^{DN*} >$

$\pi_B^{NN*} > \pi_B^{DD*}$; *(v) If* $g > \frac{2d_m[2t + e(2 + d_m)]}{2\beta d_p(2 + d_m)} - g_1$, $\pi_A^{NN*} > \pi_A^{DD*} > \pi_A^{DN*}$, $\pi_B^{DN*} > \pi_B^{NN*} > \pi_B^{DD*}$. *Here,* $g_1 = \frac{ed_m[2t + e(2 + d_m)] - 3\left[4t^2 - e^2(2 + d_m)^2\right] + 6\sqrt{\left[4t^2 - e^2(2 + d_m)^2\right]\left[t^2 - e^2(1 + d_m)^2\right]}}{2e\beta d_p(2 + d_m)}$, $g_2 = \frac{ed_m[2t + e(2 + d_m)] + 3\left[4t^2 - e^2(2 + d_m)^2\right] - 6\sqrt{\left[4t^2 - e^2(2 + d_m)^2\right](t^2 - e^2)}}{2e\beta d_p(2 + d_m)}$.

Corollary 7 shows that the impact of data services on the comparison result of the platforms' profits depends on consumer privacy composition and whether adoption is unilateral or symmetric. In all cases, both platforms earn higher profits under NN than under DD. Under unilateral adoption, however, the profit rankings vary with the proportion of privacy-sensitive consumers. In the first two regions, Platform A earns more under DN than under NN, while Platform B earns less. In the intermediate region, both platforms earn their highest profits when neither platform provides data services and their lowest profits when both provide them. Unilateral provision by Platform A yields profits between these two outcomes for each platform. Unilateral provision therefore reduces both platforms' profits relative to no adoption, although the losses are smaller than under symmetric provision. In the last two regions, Platform B benefits from Platform A's unilateral provision relative to NN, whereas Platform A loses. The extreme regions further show that DD can yield higher profits than DN for the platform disadvantaged by unilateral provision.

These comparison results of platforms' profits arise through seller participation and entry-fee competition. Data services improve matching and increase sellers' expected transaction returns. When privacy-sensitive consumers are relatively few, these benefits allow Platform A to earn more than under NN. As their proportion increases, privacy concerns shift consumer demand toward Platform B. Cross-side network effects transmit this consumer reallocation to sellers' platform choices and willingness to pay, weakening Platform A's profitability while improving Platform B's. Under DD, both platforms offer improved matching, and neither retains an exclusive service advantage. Stronger cross-side feedback makes seller participation more responsive to fee differences, intensifying competition. Equilibrium entry fees fall relative to NN, while seller shares remain equal, reducing both platforms' profits.

Hence, platforms should evaluate data-service provision against their own profits under alternative adoption profiles and anticipate competitors' subsequent responses. An advantage from unilateral provision may disappear when the competitor adopts and entry-fee competition intensifies. Consumer privacy composition also determines whether a nonprovider suffers from its rival's matching improvement or benefits from consumers switching away from that rival. Platforms should therefore assess matching benefits, privacy-induced consumer switching, seller reallocation, and equilibrium fee adjustments jointly.

Based on the comparison results of platforms' profits and the profits matrix (shown in Table 1) under the four competition scenarios, we derive the platforms' equilibrium data service adoption strategy.

Table 1. Platforms' profit matrix.

Platform A/Platform B	N	D
N	$\left(\pi_A^{NN*}, \pi_B^{NN*}\right)$	$\left(\pi_B^{DN*}, \pi_A^{DN*}\right)$
D	$\left(\pi_A^{DN*}, \pi_B^{DN*}\right)$	$\left(\pi_A^{DD*}, \pi_B^{DD*}\right)$

Proposition 2. *(i) If* $g < g_1$, *there exists a unique equilibrium, that is, each platform adopts data service regardless of its competitor's decision, and they are trapped into prisoner's dilemma; (ii) if* $g_1 < g < g_2$, *there exists a symmetric mixed-strategy equilibrium, that is, each platform*

adopts against a nonprovider and chooses nonadoption against a provider, each platform adopts with probability $\rho^* = \frac{\Lambda^2 + 6\Lambda\left[4t^2 - e^2(2+d_m)^2\right] - 9e^2d_m(4+d_m)\left[4t^2 - e^2(2+d_m)^2\right]}{2\Lambda^2 + 18e^2d_m^2\left[4t^2 - e^2(2+d_m)^2\right]}$*; (iii) if* $g > g_2$*, there exists a unique equilibrium, that is, each platform chooses nonadoption regardless of its competitor's decision.*

Proposition 2 identifies three equilibrium adoption patterns determined by the proportion of privacy-sensitive consumers. When the proportion of privacy-sensitive consumers is below the first threshold, adoption is each platform's dominant strategy, and mutual adoption is the unique equilibrium. Against a nonprovider, improved matching makes unilateral provision profitable. Against a provider, adopting is preferable to remaining the sole nonprovider because it restores matching competitiveness and improves profits relative to unilateral nonadoption. Nevertheless, both platforms earn less under mutual adoption than under mutual nonadoption. This region therefore exhibits a prisoner's dilemma. Each platform's individually profitable adoption decision contributes to stronger entry-fee competition, producing lower profits for both platforms in equilibrium.

Between the two thresholds, adoption decisions act as strategic substitutes. Each platform prefers to provide data services when its competitor does not, but prefers nonadoption when its competitor provides them. The matching benefits justify unilateral provision, while the additional competition associated with symmetric provision makes matching the competitor's adoption unprofitable. Consequently, the model admits two asymmetric pure-strategy equilibria, with either platform acting as the sole provider. These outcomes show that different service strategies can emerge even when platforms have identical initial characteristics. Consumer privacy concerns help sustain this differentiation by preserving the attractiveness of a platform that does not offer data services. When the proportion of privacy-sensitive consumers exceeds the second threshold, nonadoption becomes each platform's dominant strategy, making mutual nonadoption the unique equilibrium. Privacy-induced consumer switching makes unilateral provision unprofitable, while remaining a nonprovider is preferable to joining an adopting competitor. The expected matching benefits are therefore insufficient to justify adoption after accounting for equilibrium pricing and participation responses.

In practice, platforms should evaluate adoption using consumer privacy composition and the competitor's anticipated strategy. In the intermediate region, the same data service is profitable against a nonprovider but unprofitable against a provider, making competitive positioning central to the decision. Platforms should also anticipate how adoption changes seller entry fees and participation before committing to provision.

The main steps underlying the threshold comparisons and the adoption-equilibrium result in Proposition 2 are provided in Appendix A.

6. Conclusions and Limitations

6.1. Conclusions

This study examines whether competing e-commerce platforms should provide seller-facing data services when improved matching is accompanied by consumer privacy concerns. We develop a Hotelling model in which platforms choose whether to offer data services, set seller entry fees, and subsequently compete for consumers and sellers. Our analysis explains how data services reshape market allocation, pricing, profitability, and equilibrium adoption.

The results show that unilateral provision does not necessarily strengthen a platform's competitive position. When the proportion of privacy-sensitive consumers is sufficiently low, the provider attracts more consumers and sellers, charges a higher seller entry fee, and earns more than its competitor. As this proportion increases, the consumer-share advantage

disappears before the seller-share and profit advantages. The provider can therefore attract more sellers and earn more than its competitor while serving fewer consumers, because improved matching compensates sellers for the smaller consumer base. With sufficiently many privacy-sensitive consumers, the provider attracts fewer participants on both sides and earns less than the nonprovider, despite charging a lower entry fee.

Competitive superiority also differs from the profitability of adoption. A provider may outperform its competitor while earning less than it would under mutual nonadoption. Moreover, unilateral provision can reduce both platforms' profits relative to that benchmark. Under symmetric adoption, both platforms retain equal consumer and seller shares under the maintained full-market-coverage assumptions, but charge lower entry fees and earn lower profits than under mutual nonadoption. Improved matching strengthens cross-side feedback and intensifies competition for sellers, limiting platforms' ability to retain the resulting benefits. Inherent matching capability affects these competitive conditions, but stronger technical performance alone does not ensure more profitable data-service provision.

The adoption analysis identifies three equilibrium patterns. Below the threshold governing adoption against a provider, both platforms adopt regardless of their competitor's decision. This outcome exhibits a prisoner's dilemma because both would earn more under mutual nonadoption. Between the two adoption thresholds, each platform adopts against a nonprovider and chooses nonadoption against a provider. This region admits two asymmetric pure-strategy equilibria and a symmetric mixed-strategy equilibrium. Above the threshold governing adoption against a nonprovider, mutual nonadoption is the unique equilibrium. These regions apply where the corresponding thresholds intersect the feasible consumer population range.

The study contributes to platform competition and privacy economics by connecting consumer responses to secondary information use with seller participation, platform pricing, and endogenous service adoption. It demonstrates how privacy concerns on the consumer side affect the commercial value of services offered to sellers through cross-side network effects. The distinction between consumer-share advantages, seller-side advantages, and adoption profitability also clarifies why matching efficiency, market share, and platform profits need not move together. Furthermore, asymmetric adoption can emerge between initially identical platforms, while individually profitable adoption incentives can produce mutual adoption that reduces both platforms' profits.

For managers, the findings support evaluating data-service provision jointly with anticipated entry-fee responses and consumer and seller reallocation. Platforms should assess their inherent matching capability, the incremental matching benefits of the service, and the proportion and perceived costs of privacy-sensitive consumers. Adoption decisions should compare the platform's own profits across alternative service profiles and account for the competitor's anticipated strategy. In the intermediate region, preserving a position as the nonprovider can be preferable when the competitor offers data services. Pricing plans should also recognize that lower entry fees may not fully offset sellers' reduced transaction opportunities following consumer switching. The commercial assessment should therefore consider both the matching benefits created by data services and the entry-fee revenue platforms can retain after competition.

6.2. Limitations and Future Research

Despite the theoretical and practical value of this study, it still has certain limitations, which also point out the direction for future research.

First, the model settings are simplified. This study assumes symmetric basic attributes of two competing platforms and adopts a one-shot sequential game in which adoption decisions precede seller entry-fee setting and participation choices. In reality, platforms

differ in scale, brand influence, and initial user base, and their service strategies and users' platform choices may evolve over time. Future research can construct an asymmetric dynamic game model to explore data service strategies under different competitive patterns and how they evolve through repeated interactions, data accumulation, and changing consumer expectations. Such extensions could also clarify which platform becomes the sole provider when asymmetric adoption is sustainable.

Second, consumers and sellers single-home, and both markets are fully covered. These assumptions restrict the analysis to reallocating participants between platforms. Equal market shares when both platforms offer data services and when neither does reflect platform symmetry and full coverage, even though participant utilities differ. Future research could introduce outside options to examine whether data services expand or contract total participation. Allowing multihoming could further reveal how access to multiple platforms changes privacy-driven switching and competition through seller entry fees. Third, the representation of consumer privacy preferences and service characteristics remains simplified. This study uses binary classification to distinguish privacy-sensitive from privacy-insensitive consumers, while separately characterizing matching improvement and privacy intensification. Although this specification avoids mechanically linking technological improvement to privacy deterioration, it does not capture continuous differences in privacy sensitivity or endogenous choices concerning service quality and privacy protection. Future research can refine the measurement by incorporating continuous privacy-preference distributions and allowing platforms to choose service quality and privacy safeguards, together with their associated costs. Considering separate data-service charges would also extend the current focus on monetization through seller entry fees. These extensions could assess the robustness of the adoption thresholds and prisoner's-dilemma outcome.

Finally, there is a lack of empirical verification and consideration of external regulatory factors. This study relies on theoretical model analysis, and its conclusions need to be tested with actual e-commerce platform data. Future studies could combine adoption and pricing data with surveys or experiments measuring consumers' responses to secondary information use, thereby testing the proposed links between consumer switching, seller participation, and entry fees. Additionally, privacy regulation remains outside the model. Future research can conduct empirical tests and incorporate regulatory variables such as consent requirements, restrictions on secondary information use, and compliance costs to examine their effects on service design, competitive pricing, and equilibrium adoption.

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Appendix A

Appendix A.1. Equilibrium Verification and Admissibility

We use the parameter restrictions and the definition of Λ stated in Sections 3 and 4.2. The maintained condition $t > \max\{e(1+d_m), e+\beta d_p\}$ implies that the equilibrium denominators are positive.

Under DN, differentiating each platform's profit with respect to its own entry fee gives

$$\frac{\partial \pi_i^{DN}}{\partial f_i^{DN}} = n_i^{DN} - \frac{2t f_i^{DN}}{4t^2 - e^2(2+d_m)^2} = 0$$

Solving the two first-order conditions simultaneously yields the entry fees reported in Section 4.2. Substitution into the participation functions gives the corresponding consumer shares, seller shares, and profits. The second-order conditions are

$$\frac{\partial^2 \pi_i^{NN}}{\partial (f_i^{NN})^2} = -\frac{t}{t^2 - e^2} < 0$$

$$\frac{\partial^2 \pi_i^{DN}}{\partial (f_i^{DN})^2} = -\frac{4t}{4t^2 - e^2(2+d_m)^2} < 0$$

$$\frac{\partial^2 \pi_i^{DD}}{\partial (f_i^{DD})^2} = -\frac{t}{t^2 - e^2(1+d_m)^2} < 0$$

The maintained restrictions also imply

$$-\left[4t^2 - e^2(2+d_m)^2\right] < \Lambda < 4t^2 - e^2(2+d_m)^2$$

Since $g\beta d_p < t - e$, we have

$$\Lambda + 4t^2 - e^2(2+d_m)^2 > 4t(t-e) > 0$$

Consequently, the DN equilibrium entry fees are positive and each platform's seller share lies strictly between one-third and two-thirds. It ensures the existence of our equilibrium outcomes.

Appendix A.2. Derivation of the Comparison Thresholds

Subtracting the DN equilibrium outcomes gives

$$f_A^{DN*} - f_B^{DN*} = \frac{\Lambda}{6t}$$

$$n_A^{DN*} - n_B^{DN*} = \frac{\Lambda}{3\left[4t^2 - e^2(2+d_m)^2\right]}$$

$$\pi_A^{DN*} - \pi_B^{DN*} = \frac{\Lambda}{6t}$$

Since all three differences have the sign of Λ, setting Λ equal to zero therefore yields the common threshold in Corollaries 1 and 3 and Proposition 1.

The consumer-share difference is

$$m_A^{DN*} - m_B^{DN*} = \frac{e d_m - 2g\beta d_p}{2t} + \frac{e(2+d_m)\Lambda}{6t\left[4t^2 - e^2(2+d_m)^2\right]}$$

Setting this difference equal to zero gives

$$g = \frac{e d_m [3t - e(2+d_m)][2t + e(2+d_m)]}{2\beta d_p \left[6t^2 - e^2(2+d_m)^2\right]}$$

which establishes the threshold in Corollaries 2 and 5. Because NN and DD both yield one-half of consumers and sellers on each platform, comparison with either symmetric profile gives the same consumer-share and seller-share boundaries.

The entry-fee comparisons follow from

$$f_A^{DN*} - f_A^{NN*} = \frac{\Lambda - 3e^2 d_m(4 + d_m)}{12t}$$

$$f_A^{DN*} - f_A^{DD*} = \frac{\Lambda + 3e^2 d_m(4 + d_m)}{12t}$$

The corresponding expressions for Platform B are obtained by replacing Λ with $-\Lambda$. Setting these four differences equal to zero, we yield the four entry-fee boundaries in Corollary 4.

For the profit comparisons, the equality between Platform A's DN and NN profits is equivalent to

$$3\left[4t^2 - e^2(2 + d_m)^2\right] + \Lambda = 6\sqrt{\left[4t^2 - e^2(2 + d_m)^2\right](t^2 - e^2)}$$

Substituting Λ and solving for g gives g_2. Similarly, equality between Platform B's DN and DD profits is equivalent to

$$3\left[4t^2 - e^2(2 + d_m)^2\right] - \Lambda = 6\sqrt{\left[4t^2 - e^2(2 + d_m)^2\right]\left[t^2 - e^2(1 + d_m)^2\right]}$$

Solving this equation gives g_1. The remaining profit boundaries follow from the same comparisons with Λ replaced by $-\Lambda$. Combining these boundaries with the common NN–DD profit ordering yields Corollary 7.

Appendix A.3. Proof of Proposition 2

When the competitor does not offer data services, a platform compares its profit as the sole provider with its NN profit. When the competitor offers data services, it compares its DD profit with its profit as the sole platform that does not offer the service. Therefore, when $g < g_2$, $\pi_A^{DN*} > \pi_A^{NN*}$ holds. Similarly, when $g < g_1$, $\pi_A^{DD*} > \pi_A^{DN*}$ holds.

Since $g_2 - g_1 = t^2 e^2 d_m^2 > 0$, we derive that below g_1, offering data services is a strictly dominant strategy for both platforms, so DD is the unique equilibrium. Between g_1 and g_2, each platform offers the service against a competitor that does not offer it and chooses not to offer it against a competitor that does. Hence DN and ND are the two asymmetric pure-strategy equilibria. Above g_2, neither platform offering the service is supported by strictly dominant strategies, so NN is the unique equilibrium.

In the intermediate region $g_1 < g < g_2$, equating the expected payoffs from offering and not offering, we derive the symmetric mixing probability is $\rho = \frac{\pi_A^{DN*} - \pi_A^{NN*}}{\pi_A^{DN*} - \pi_A^{NN*} + \pi_B^{DN*} - \pi_A^{DD*}}$. Since $\pi_A^{DN*} > \pi_A^{NN*}$, $\pi_B^{DN*} > \pi_A^{DD*}$, the probability ρ lies strictly between zero and one. Substitution of the equilibrium profits yields the expression reported in Proposition 2.

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