Essays on the Industrial Organization of Digital Platform Markets

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1 Preface

Daily tasks increasingly rely on digital services, with platforms serving as intermediaries that connect users. Digital platforms provide an infrastructure that facilitates user interaction and thereby play a central role in modern economies. Such an infrastructure might be a digital marketplace that manages trade between consumers and sellers. Depending on the markets in which platforms operate, sellers may offer products or services. For instance, consider the e-commerce platform *Amazon.com*, which hosts a wide product range from books to kitchenware in its marketplace. Other e-commerce platforms are more specialized. For example, *Zalando* and *Spartoo* focus on fashion. There are also service platforms that offer a marketplace where service providers and consumers meet. Prominent examples for service platforms are the restaurant-booking platform *OpenTable* or the beauty-salon platform *treatwell*.

On such platforms, consumers as well as sellers value the presence of many of their counterparts. These positive cross-group network effects cause an interdependence between the two market sides. The decision of consumers to join a platform depends on the presence of a sufficiently large number of sellers, whereas sellers' participation similarly depends on consumer participation, resulting in a coordination problem referred to as chicken-and-egg problem. Chapter 2 of this dissertation examines this coordination problem faced by online platforms in the launch phase and analyzes how platforms can overcome it through an optimal information strategy.

Due to positive cross-group network effects, platforms with larger user bases provide higher value to their users, leading to market concentration around a few established platforms. Given the tendency toward concentration, Chapter 3 considers a platform duopoly, whereas Chapter 4 considers a platform monopoly. Both chapters explore how platforms' strategic decisions restrict the set of actions available to sellers. In particular, Chapter 3 examines under what circumstances platforms require sellers to offer their products exclusively on their platform and analyzes the implications of such exclusivity clauses. Chapter 4 investigates whether a platform has an incentive to share data on consumer insights with sellers, thereby shaping the competitive dynamics in the marketplace. Additionally, the chapter investigates how these data-sharing incentives change when the platform becomes active as a seller in its own marketplace.

The chapters of this dissertation analyze different stages in the evolution of platform markets. Despite their thematic connections, each chapter is self-contained and addresses a specific aspect related to the industrial organization of platform markets. The contents of each chapter are summarized in the following.

Chapter 2 considers an early stage of a platform market where the market is initially organized offline. A digital platform attempts to enter the market in order to facilitate the interaction of consumers and sellers. Consumers and sellers face a coordination problem on whether joining the platform or not. They obtain higher utilities and profits when joining the platform, and when enough other users join as well. However, consumers and sellers incur costs when joining the platform. If too few users join the platform, consumers and sellers who have decided to join realize the initial utilities and profits from interacting with one another offline. Additionally, those users incur the cost of joining the platform. The coordination behavior of consumers and sellers is modeled by using a global-game approach. The platform's aim is to maximize the probability that a sufficient number of consumers and sellers participate. To achieve this aim, the platform can implement an information strategy during the initial market phase. We find that the optimal information channel depends on the market sentiment regarding the technology value of the platform. If the market sentiment is optimistic, the platform should use public information channels, such as social media posts or a poster campaign, to inform all users about its services. However, if the technology value of the platform is expected to be low, the platform should focus on private seller information channels. For example, it can offer individual consultations or configuration test versions to increase the probability of its establishment success.

In Chapter 3, a market with two competing platforms is considered. Consumers and sellers are horizontally differentiated in their preferences for a platform and join the platform which fits their preferences best. They obtain a positive cross-group network benefit from interacting with the other market side on the same platform. Consumers can join platforms for free, while sellers have to incur a membership fee when joining. Therefore, the platforms' profit is generated through the membership fee for sellers. Consumers may singlehome by joining one platform or multihome by joining both. Platforms may issue exclusivity clauses to sellers such that sellers can only join a single platform. Consequently, fewer sellers join a platform in the exclusive setting than in a setting where sellers can join both platforms. We find that membership fees for sellers are higher in the setting with exclusivity clauses than without. Therefore, platforms require sellers to be exclusive on a platform when the higher membership fee outweighs the additional sellers who join in a non-exclusive setting. When sellers are required to act exclusively on a platform, consumers react by multihoming themselves. Therefore, consumers suffer from a higher cost of joining both platforms in the aggregate. Consequently, seller exclusivity has a negative effect on the consumer surplus. To consider the effect on total welfare, the sellers' perspective is also taken into account. Sellers suffer from exclusivity clauses if consumers' incentives to multihome are not very pronounced, because then sellers cannot react to low consumer participation by joining both platforms. Additionally, their membership fee is particularly high in that case. However, if platforms' competition on membership fees is intensive in the exclusive setting, the membership fee in the exclusive setting is not much higher than in the non-exclusive setting and sellers may benefit from the platforms' decision for exclusivity. In this specific case, exclusivity clauses can be welfare-enhancing. Nevertheless, exclusivity clauses predominantly harm total welfare.

In Chapter 4, it is assumed that the market tipped toward monopolization. Therefore, the platform is a gatekeeper for sellers to access consumers. As a marketplace, the platform intermediates between consumers and two sellers that offer substitutable products. Sellers pay a proportional fee on their prices to the platform. The platform is hybrid, meaning it can either act as a pure marketplace or it merges with one of the two sellers and operates in the dual mode. In the dual mode, the platform competes with the independent seller it hosts. The platform collects data on consumers' preferences through its marketplace activities and can decide whether to share data with the sellers in the marketplace. Data access enables sellers to adapt their products so that consumers obtain higher utilities and sellers can set higher prices. We find that the platform generates higher profits when it becomes active as a seller. In this case, the platform shares data with the rival seller if the proportional marketplace fee is sufficiently high or the products of the seller and the platform are not close substitutes. Otherwise, the platform uses the data exclusively and thereby gains a competitive advantage compared to the independent seller. If the platform uses the data exclusively, the platform's choice is misaligned with the consumers' perspective. The consumer surplus and the total welfare are higher when data is shared with the independent seller. The market outcome can be improved from a welfare perspective by implementing data-sharing obligations.

The aim of this dissertation is to contribute to a better understanding of the driving forces that shape platform markets. Each chapter highlights relevant platform characteristics in a stylized form to isolate and explain the underlying effects. Together, the derived findings improve the theoretical understanding of platform economics and provide insights for platforms, users, and policymakers.

2 Managing the Establishment of Service Platforms*

Abstract

We study a global game in which consumers and sellers decide whether to join a service platform and interact more efficiently online. Uncertainties about the platform's technology value and users' participation behavior on both market sides cause a coordination problem. Facing this problem, the platform management can strategically influence the probability of a successful establishment through its information policy. When users' expectations about the platform's technology value are pessimistic, the platform can increase its success probability by addressing sellers through individual information channels. When expectations are optimistic, the platform can increase this probability by addressing users through public information channels.

Keywords: Two-sided service platforms, global coordination games, information management
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2.1 Introduction

Making a medical appointment often requires to reach a front-desk clerk, and it can take a lot of back and forth to find a date that suits both parties. A service platform promises to improve this time-intensive procedure by allowing consumers to select an online appointment in the doctors' virtual calendar. Numerous start-ups try to launch such a platform business model in several service markets. However, platforms trying to establish are confronted with a chicken-and-egg problem: A critical mass of consumers and sellers has to join the platform for its successful establishment. According to a study by BCG, 2020, 45% of ecosystems fail to attract enough users during the scaling phase. Service platforms such as the doctors' platform *Doctolib* or the beauty-salon platform *treatwell* have attracted large numbers of users in Europe and have been active for more than ten years now. As of October 2025, 410,000 health care professionals and 80 million patients registered on *Doctolib* (Doctolib, n.d.). The platform *treatwell* lists more than 75,000 salons and processes more than 5 million bookings every month (treatwell, n.d.). The restaurant-booking platform *OpenTable* operates worldwide with 50,000 restaurants and 31 million monthly reservations (OpenTable, n.d.). However, success is not guaranteed. As pointed out, several service platforms fail to establish. One example is the platform *Store2be* for stationary promotion and sales rentals which was forced to exit the market seven years after its foundation (deutsche startups, 2020). Another example is the restaurant-booking platform *DiscoEat*, which went into insolvency five years after its foundation (deutsche startups, 2024).

To explain this evidence, this chapter considers, as a starting point, a traditional, decentralized market where consumers and sellers interact with each other offline. An online service platform attempts to enter this market as an intermediary. It enables a more efficient communication between consumers and sellers if enough market participants decide to go online. We derive the consumers' and sellers' decisions to switch to the online platform, facing uncertainty about the participation behavior of users on both market sides and, hence, the platform's probability of establishment. In order to identify decisive factors explaining the platform's establishment, we solve a global game of consumer and seller coordination.

As an additional contribution, our model enables us to study how a platform's information management can strategically influence its probability of success. During the launch phase of a new business, it is essential that it gains visibility. This is particularly relevant in platform markets, since a platform's success depends on a balanced user adoption from both the seller and consumer side. Therefore, the information policy should be an integral part of a platform's launch strategy. We show that the optimal management policy is to provide additional personalized or public information about the platform's technology value to reduce users' uncertainty and, thereby, to increase the probability of a successful establishment. We point out that the choice of the appropriate information channel depends decisively on the market sentiment. If the market sentiment is rather pessimistic, i.e., if users' expectations about the platform's technology value are low, the platform should provide sellers with additional personalized information to reduce their private uncertainty. In contrast, if the market sentiment is rather optimistic, i.e., if users' expectations about the technology value are high, the platform should provide all users with additional public information to reduce common uncertainty. Therefore, both types of information policy should be considered as options of the managers' business strategies. Evidently, implementing such sophisticated business strategies requires a careful preliminary analysis of the relevant market in terms of the potential users' perceptions of the platform's technology value.

The remainder of the chapter is organized as follows: Section 2.2 relates our model to the previous platform literature. This enables us to emphasize the benefits of using a global-game approach. Section 2.3 explains the setup of the model. Section 2.4 derives the equilibrium of the coordination game and interprets the results. Section 2.5 considers possible instruments of the platform's information management by endogenizing its information strategy. Finally, Section 2.6 concludes the chapter.

2.2 Related Literature

A platform serves as an intermediary between two or more market sides. By lowering search costs and facilitating communication between market sides, it generates substantial efficiency gains (Evans and Schmalensee, 2008; Spulber, 2010). We consider the launch phase of a two-sided platform that connects consumers and sellers online. Due to positive network externalities across users on both sides of the platform, consumers and sellers are confronted with a chicken-and-egg coordination problem which has been studied extensively in the game theoretical literature.

A platform can use the divide-and-conquer pricing strategy to solve this coordination problem by ensuring that users on both sides of the platform join. The idea is to subsidize one market side whose agents react by joining the platform. Consequently, agents from the other market side are also attracted and even willing to pay a membership fee to access the platform (Caillaud and Jullien, 2003; Segal, 2003;

Armstrong, 2006; Belleflamme and Toulemonde, 2009). Hagiu and Spulber (2013) introduce a non-pricing element to avoid the non-participation problem: A platform invests in providing own content to motivate one or the other market side to join the platform. The literature studies several other instruments applied to attract market participants. For example, Cui and Li (2024) examine how platforms can improve their service by implementing recommendation systems that increase consumer utility. In the model of Bimpikis et al. (2024), the platform decides whether to disclose information about the quality of service providers, thereby influencing users' participation behavior.

Another type of coordination problem arises in the case of a platform duopoly, where users must coordinate across both platforms. The concept of focality provides a solution to this problem. A platform is focal if users expect it to be able to attract other users. Focality can be caused by incumbency. The rival opposes the focal platform by offering higher quality and sufficiently lower prices (Jullien, 2011; Halaburda and Yehezkel, 2018; Halaburda, Jullien, et al., 2020). In these models, users share the same beliefs about the platforms' success. Our model extends this strand of the literature by considering heterogeneous user beliefs. Contrary to the duopolistic market structure, we start with an offline market existing before an efficiency-enhancing platform attempts to establish.

Ambrus and Argenziano (2009) consider a game where heterogeneous consumers play a coalitional rationalization strategy in each subgame. Due to the heterogeneity of consumers' valuation of the network good, multiple differentiated platforms can coexist in a market. Evans and Schmalensee (2010) take into account users who are heterogeneous in the network benefits they obtain from meeting other users. As in our setting, they focus on the launch phase of a platform. They emphasize the importance of attaining a critical mass on both sides and elaborate on the adjustment dynamics. However, in contrast us, the authors do not offer policy recommendations to influence the probability of a successful launch. Lingga et al. (2025) examine the specific case of the market entry of a telehealth platform where consumers have idiosyncratic preferences regarding doctors. The authors argue that in less developed markets, telehealth platforms host too few doctors, requiring correction through governmental intervention via an appropriate tax-subsidy. In their setting, welfare can be enhanced by providing doctors with a subsidy funded by a tax imposed on the platform for each transaction, resulting in increased participation from both doctors and patients.

User heterogeneity can alternatively be captured in terms of individual and incomplete user beliefs. Jullien and Pavan (2019) consider users' expectations on competing platforms' standalone values and stress the relevance of platforms' information management for a platform's pricing strategy. As in our setting, participants receive dispersed information. The authors assume that all participants join a platform, whereas our model focuses on the establishment of a platform. Chellappa and Mukherjee (2021) examine competing platforms' preannouncement strategies in a two-sided market when launching a new platform version. By providing information about this version, platforms can raise agents' expectations about network effects. Then, the optimal preannouncement strategy depends on the differentiation of agents' taste preferences. Again, the analysis focuses on well-established platforms but not on the initial platform launch phase.

A key feature of platform markets is the technological improvement offered by a (new) platform. Kamepalli et al. (2022) consider users' coordination behavior when an incumbent platform is already established in a market and a technologically advanced platform enters this market. They analyze app-designers' (analogous to sellers in our framework) decisions to adapt to a new app store (analogous to our platform) that provides a technology improvement compared to the existing app store. As in this chapter, they use a global-game framework. However, while they study the switching behavior of one market side, we use the global-game approach to analyze the joining behavior of both market sides. In our model, the participation of both market sides is crucial for the platform's establishment. Kamepalli et al. (2022) focus on the incumbent platform's possibility to acquire the entrant platform to ensure the monopoly position. This allows them to derive antitrust policy implications. This chapter considers an earlier stage of the platform market. We start with an environment in which the market is decentralized and organized offline. The opening of the platform possibly enables consumers and sellers to increase utilities and profits. Our policy implications focus on the optimal information-management strategy that helps an entrant platform to establish.

The management literature devotes considerable attention to the launch phase of two-sided platforms. Several contributions identify optimal strategies for start-up platforms to overcome the chicken-and-egg problem (Eisenmann et al., 2006; Evans, 2009; Stummer et al., 2018; Mancha et al., 2021). The analysis by Veisdal (2020) is based on interviews with platform managers about their solutions to this challenge. In the launch phase, the established platforms prioritize creating value for the sellers and raising users expectations about the future dominance of the platform through mass media. Awais (2024) empirically studies the role of information provision during the launch phase of tech firms. He considers the efficiency of different acquisition channels and finds that search engine optimization and email marketing are the most efficient ones. However, information flows remain difficult to capture empirically. Therefore, a theoretical analysis provides a valuable complementary approach to study the optimal provision of private and public information during the launch phase of a platform.

2.3 Model Setup

We consider the decision problem of a continuum of consumers $i \in [0,1]$ and sellers $j \in [0,1]$. In the initial state, no platform exists and consumers and sellers traditionally interact offline. Consumers realize the utility $\underline{u}$ from this interaction, sellers earn the profit $\underline{\pi}$. An online service platform attempts to enter the market. As soon as the platform opens, consumers and sellers decide whether to stay offline or join the platform (at costs) and interact more efficiently online. We focus on the launch phase of the platform. Therefore, the sole objective of the platform is to establish in the market. A successfully established platform has market presence through awareness and reputation in the market and retains a stable user base of consumers and sellers. The problem is that users ex-ante do not know whether the platform will succeed in persisting in the market.

The platform's business model is to intermediate between the consumer and the seller side. This is accomplished by providing a website and applications that enable the matching and communication between market sides. The technology value θ of the platform represents the quality and technological maturity of the website and the applications.[1] The quality of the website is characterized by factors such as web design, user experience, data processing[2] and security standards. Additionally, the website's quality increases when content is tailored to the interests of the target group. For example, a restaurant-booking platform might provide expert interviews with celebrity chefs on current industry topics. Applications can also contain features to improve sellers' internal processes, e.g., an application to organize tables in a restaurant or an automated waiting list. In addition to the technology value θ, the platform's establishment depends on the traffic generated through online consumers and sellers. We denote the proportion of platform-joining consumers by n and the

[1] Kamepalli et al. (2022) interpret θ as the incremental quality improvement the entrant platform provides compared to the incumbent platform.

[2] For a comprehensive analysis of the role of data processing as a decisive determinant of platforms' success, see Wang, Zhen et al. (2024).

proportion of joining sellers by m. The platform establishes if its website and apps are appealing and technically mature and if many users are active. Thereby, the platform incurs a cost to set up the platform business that must not exceed the monetary value attributed to the technology and the user base. To capture these requirements analytically, we set up the establishment condition that has to be satisfied in order to persist in the market. As a tractable establishment condition, we assume $\theta + \alpha n^{\gamma} m^{1-\gamma} > f$, where $\alpha > 0$ is a weight parameter that captures the monetary value of user participation and $f > 0$ denotes the fixed cost of setting up the platform.[3] The contribution of user participation is specified as a Cobb-Douglas function where $\gamma \in [0, 1]$ measures the relative importance of both user groups. The Cobb-Douglas formulation takes into account that joint participation of both market sides is conducive for the platform's establishment.

In the extreme case of $\theta > f$, the platform setup is inherently successful because the mature software creates a value that exceeds the cost. The platform is accessible in the market and users derive efficiency gains by joining the platform due to the technological benefit the software provides, even if no other user joins. In this case, however, it is actually a software solution rather than a platform. In the restaurant booking example, this might be a solution for restaurants that provides a feature for the table organization or a checkout system. In the opposite extreme case of $\theta < f - \alpha$, the platform inherently fails to establish since the fixed cost exceeds the value attributed to the low-quality software even if all potential consumers and sellers join. Consequently, the platform cannot persist in the market.

In the interesting intermediate case of $\theta \in [f - \alpha, f]$, the platform's establishment depends on the requirement that sufficient proportions of users on both market sides decide to go online. Becoming active to join the platform causes a fixed cost c_c for every consumer and a fixed cost c_s for every seller. Consumers joining the platform enjoy the higher net utility $\bar{u} - c_c > \underline{u}$ if the platform is established. Analogously, the net profit of sellers switching to the platform increases to $\bar{\pi} - c_s > \underline{\pi}$. When using the platform, consumers benefit from the possibility to book services at any time and adjust the appointment to their personal schedule. Sellers save costs by using the platform as fewer working hours have to be spent on organizing appointments and automated reminders reduce no-shows. If users stay passive, their payoffs remain $\underline{u}$ and $\underline{\pi}$, respectively.

[3] Our analysis focuses on the platform's establishment success, i.e., whether the establishment condition is fulfilled or not. The difference between the sum of the technology value and the monetary value of user participation on the one hand and the fixed cost on the other can be interpreted as the platform's market value.

If only few users are willing to join, the platform fails to establish. Then, the active users realize the utility $\underline{u}$ and the profit $\underline{\pi}$ as in the initial offline state, but the costs c_c and c_s of a possible accession are sunk. The users' decision to join the platform and to incur a fixed cost is made simultaneously and non-cooperatively.

Contrary to other platform models, users' utility and profit functions do not depend directly on the number of opposite agents (cross-group network effect). Instead, the network aspect is captured by the user participation requirement in the platform's establishment condition. We restrict our analysis to service-booking platforms because service providers have limited capacities so that their primary objective is not to expand consumer demand, but to streamline processes and realize cost savings. These cost savings only occur if the platform persists in the market because enough sellers and consumers join. Consumers use the platform to book appointments. Therefore, the profit function of a service provider has a binary character. Either the service provider can realize cost savings or not. The mechanism is analogous on the consumer side. Consumers use a fixed number of services. They can increase their utility when they register on the platform and book their services via the platform, given that it is established and service providers are active. Tables 2.1 and 2.2 summarize the payoff structures for consumers and sellers, respectively.

Table 2.1: Consumers' Payoff Structure

Platform's establishment	fails $\theta + \alpha n^{\gamma} m^{1-\gamma} \leq f$	succeeds $\theta + \alpha n^{\gamma} m^{1-\gamma} > f$
Passive consumer	$\underline{u}$	$\underline{u}$
Active consumer	$\underline{u} - c_c$	$\bar{u} - c_c$

Table 2.2: Sellers' Payoff Structure

Platform's establishment	fails $\theta + \alpha n^{\gamma} m^{1-\gamma} \leq f$	succeeds $\theta + \alpha n^{\gamma} m^{1-\gamma} > f$
Passive seller	$\underline{\pi}$	$\underline{\pi}$
Active seller	$\underline{\pi} - c_s$	$\bar{\pi} - c_s$

Consumers as well as sellers have incomplete information about the technology value of the platform and the participation behavior of the other users. Therefore, potential users face uncertainty about the platform's ability to persist in the market. When the platform's website and applications become accessible, users form expectations about the platform's technological capability and about the participation decision of all other potential users. Based on these expectations, all users decide whether to join the platform. After the joining decisions are made, the platform either establishes or not. We start our analysis by describing the users' formation of expectations within the global-game framework.

The solution concept of global games (see, e.g., Morris and Shin (2003)) presents an appropriate method to derive a unique Bayesian equilibrium in the coordination game at hand. As is common in the global games literature, we assume that, from the users' perspective, the value θ is a normally distributed random variable with mean $E(\theta) = \mu$ and variance $V(\theta) = \tau^2$. These distributional properties are common knowledge among users so that we refer to them as users' *public information* component. The mean μ represents the average prior expectations of consumers and sellers about the technology value of the platform. The variance τ^2 measures the distribution's dispersion around μ so that its inverse $1/\tau^2$ is the precision of public information about the value θ. Thus, if public information is very precise, the distribution of θ is closely centered around μ which, in turn, is a good predictor of θ.

As soon as the platform's website and applications become accessible, consumers and sellers receive noisy signals about its technology value. In the launch phase, the users observe their signals by reviewing the website and the applications. Based on their signals, users form expectations about the platform's establishment probability. Every consumer receives the individual signal

$$x_i = \theta + \varepsilon_i \ ,$$

where the noise parameters ε_i are identically and independently drawn from a normal distribution with mean $E(\varepsilon_i) = 0$ and variance $V(\varepsilon_i) = \sigma_c^2$. The noise parameter exemplifies the consumers' individual distortion, e.g., due to technical suspicion or optimism. In the equilibrium of the global game, consumer i stays offline if its individual signal is bad, $x_i \leq x_c^*$, but joins the platform if its signal is good, $x_i > x_c^*$. A consumer receiving the critical signal x_c^*, which will be endogenously determined in the equilibrium, is indifferent between staying offline and going online.

Similarly, every seller receives the individual signal

$$x_j = \theta + \varepsilon_j \ ,$$

where the noise parameters ε_j are identically and independently drawn from a normal distribution with mean $E(\varepsilon_j) = 0$ and variance $V(\varepsilon_j) = \sigma_s^2$. Seller j stays offline if $x_j \leq x_s^*$, but joins the platform if $x_j > x_s^*$, where a seller receiving the endogenously determined critical signal x_s^* is indifferent between joining the platform or not.

The individual signals x_i and x_j are unobservable for the other users due to the idiosyncratic error terms ε_i and ε_j, which we refer to as users' *private information* components. Therefore, the terms $1/\sigma_c^2$ and $1/\sigma_s^2$ indicate the precision of private information of consumers and sellers, respectively. If the precision of private information is high, the distributions of the error terms are closely centered around $E(\varepsilon_i) = 0$ and $E(\varepsilon_j) = 0$ so that users' signals precisely mirror the actual technology value θ.

In global games, the critical individual signals x_c^* and x_s^* are interrelated via the equilibrium threshold value θ^* and jointly determine the platform's establishment probability. If the realized technology value is below the critical value, i.e., $\theta \leq \theta^*$, too few consumers and sellers decide to join the platform so that its establishment fails. However, if $\theta > \theta^*$, sufficient proportions of consumers and sellers join the platform that therefore succeeds to establish.[4] In Appendix A2.1, we prove that the payoff structure fulfills the required conditions for the existence of a unique threshold equilibrium which is described by the two critical signals x_c^* and x_s^* as well as the threshold value θ^*.

2.4 Equilibrium Solution of the Global Game

To derive the equilibrium solution of the global game, we first consider the proportions of joining consumers and sellers. Users join the platform if their individual signals about the platform's technology value are good, i.e., above the critical signal of the respective market side. Thus, the conditional probability that consumer i's individual signal x_i is above the critical signal x_c^* equals the conditional probability that this consumer joins the platform,

$$P(x_i > x_c^*|\theta) = 1 - P(x_i \leq x_c^*|\theta) = 1 - \Phi\left(\frac{x_c^* - \theta}{\sigma_c}\right) = \Phi\left(\frac{\theta - x_c^*}{\sigma_c}\right),$$

where $\Phi(\cdot)$ denotes the standard normal distribution function. Since we consider a continuum of consumers in the unit interval $i \in [0, 1]$, the probability of an individual consumer observing a signal above the critical x_c^* is equal to the proportion n of

[4] As one limit case, the non-establishment equilibrium captures the non-participation equilibrium where no potential user joins the platform. As the other limit case, the establishment equilibrium captures the full-participation equilibrium where all potential users join the platform.

consumers joining the platform. Thus, this proportion is determined as

$$n = \Phi\left(\frac{\theta - x_c^*}{\sigma_c}\right).$$

Similarly, the probability of an individual seller j joining the platform is

$$P(x_j > x_s^*|\theta) = \Phi\left(\frac{\theta - x_s^*}{\sigma_s}\right),$$

and the proportion m of sellers joining the platform is determined as

$$m = \Phi\left(\frac{\theta - x_s^*}{\sigma_s}\right).$$

The platform successfully establishes if its technology value surpasses the critical value. To derive this threshold value at which the platform is on the brink of failure or success, we use the establishment condition at equality, i.e., $\theta^* = f - \alpha n^\gamma m^{1-\gamma}$. Inserting the proportions of joining consumers n and sellers m yields the *critical-mass condition*

$$\theta^* = f - \alpha \left(\Phi\left(\frac{\theta^* - x_c^*}{\sigma_c}\right)\right)^\gamma \left(\Phi\left(\frac{\theta^* - x_s^*}{\sigma_s}\right)\right)^{1-\gamma}. \tag{2.1}$$

Let us now consider users' joining decisions which are based on their assessment of the platform's establishment probability. From the perspective of consumer i with signal x_i, the conditional probability that the platform establishes is

$$P(\theta > \theta^*|x_i) = 1 - \Phi\left(\frac{\theta^* - E(\theta|x_i)}{\sqrt{V(\theta|x_i)}}\right).$$

The conditional expected value of θ, given the individual signal x_i, proves to be a linear combination of the mean $E(\theta) = \mu$ and the individual signal x_i:

$$E(\theta|x_i) = \frac{\sigma_c^2}{\sigma_c^2 + \tau^2}\mu + \frac{\tau^2}{\sigma_c^2 + \tau^2}x_i.$$

The conditional variance proves to be

$$V(\theta|x_i) = \frac{\sigma_c^2\tau^2}{\sigma_c^2 + \tau^2}.$$

Using these expressions, consumers face the conditional probabilities of the platform's successful establishment

$$P(\theta > \theta^*|x_i) = 1 - \Phi\left(\frac{\sqrt{\sigma_c^2 + \tau^2}}{\sigma_c \tau}\left(\theta^* - \frac{\sigma_c^2}{\sigma_c^2 + \tau^2}\mu - \frac{\tau^2}{\sigma_c^2 + \tau^2}x_i\right)\right).$$

Given these conditional probabilities, consumers can weight their net utility with the probability of the respective market outcome when making their joining decision. The consumers consider the conditional probability of the platform's successful establishment and the higher utility they receive from this outcome given that they join the platform. However, they also take into account the conditional probability of platform failure and the associated cost of joining the platform at the lower utility. They weigh up these possible outcomes against the utility they obtain when not going online. The condition of a consumer being indifferent between passively staying offline and actively going online reads

$$\underline{u} = P(\theta > \theta^*|x_c^*)(\bar{u} - c_c) + P(\theta \leq \theta^*|x_c^*)(\underline{u} - c_c).$$

By inserting the conditional probabilities at $x_i = x_c^*$, we obtain the *consumers' cutoff-condition*

$$x_c^* = \frac{\tau^2 + \sigma_c^2}{\tau^2}\left(\theta^* - \frac{\sigma_c^*}{\tau^2 + \sigma_c^2}\mu + \frac{\tau \sigma_c}{\sqrt{\tau^2 + \sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u} - \underline{u}}\right)\right). \tag{2.2}$$

Consumers who receive a signal above this critical signal join the platform. The sellers' joining decisions are derived accordingly. Seller j's conditional expected value of θ, given the individual signal x_j, is

$$E(\theta|x_j) = \frac{\sigma_s^2}{\sigma_s^2 + \tau^2}\mu + \frac{\tau^2}{\sigma_s^2 + \tau^2}x_j\ ,$$

the conditional variance reads

$$V(\theta|x_j) = \frac{\sigma_s^2 \tau^2}{\sigma_s^2 + \tau^2}\ .$$

Thus, the conditional probability of the platform's successful establishment, given the individual seller j's signal, is

$$P(\theta > \theta^*|x_j) = 1 - \Phi\left(\frac{\sqrt{\sigma_s^2 + \tau^2}}{\sigma_s \tau}\left(\theta^* - \frac{\sigma_s^2}{\sigma_s^2 + \tau^2}\mu - \frac{\tau^2}{\sigma_s^2 + \tau^2}x_j\right)\right).$$

The seller is indifferent between passively staying offline and becoming active to go online if

$$\underline{\pi} = P(\theta > \theta^*|x_s^*)(\bar{\pi} - c_s) + P(\theta \leq \theta^*|x_s^*)(\underline{\pi} - c_s).$$

Based on their individual signals, some sellers decide to join the platform, while others find it advantageous to stay offline. By inserting the conditional probabilities at $x_j = x_s^*$, we obtain the *sellers' cutoff-condition*

$$x_s^* = \frac{\tau^2 + \sigma_s^2}{\tau^2}\left(\theta^* - \frac{\sigma_s^*}{\tau^2 + \sigma_s^2}\mu + \frac{\tau\sigma_s}{\sqrt{\tau^2 + \sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi} - \underline{\pi}}\right)\right). \tag{2.3}$$

By inserting the two cutoff-conditions (2.2) and (2.3) into the critical-mass condition (2.1), we finally obtain the implicit solution for the platform's technology threshold value

$$\begin{aligned}\theta^* =& f - \alpha\left(\Phi\left(\frac{\sigma_c}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2 + \sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u} - \underline{u}}\right)\right)\right)\right)^{\gamma} \\ &\left(\Phi\left(\frac{\sigma_s}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2 + \sigma_s^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi} - \underline{\pi}}\right)\right)\right)\right)^{1-\gamma}.\end{aligned} \tag{2.4}$$

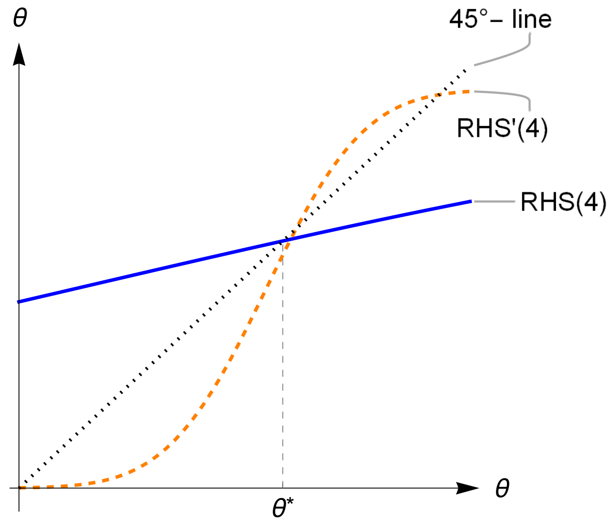
For $\theta > \theta^*$, the platform is successfully established; otherwise, it fails. Consumers receiving a good signal $x_i > x_c^*$ and sellers receiving a good signal $x_j > x_s^*$ join the platform, the other users stay offline.

A unique equilibrium solution for θ^* exists if there is exactly one solution for θ^* solving (2.4). This is the case if the slope of the right-hand side (RHS) of (2.4) does not exceed 1, i.e., $\frac{dRHS(2.4)}{d\theta^*} < 1$. Inserting the implicit derivative of (2.4) and the maximum value $\phi(\cdot) = 1/\sqrt{2\pi}$ of the density of the standard normal distribution into the inequality condition $\frac{dRHS(2.4)}{d\theta^*} < 1$ gives the sufficient condition

$$\begin{aligned}&\left(\frac{\Phi\left(\frac{\sigma_c}{\tau^2}\left(\theta^* - \mu + \frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right)}{\Phi\left(\frac{\sigma_s}{\tau^2}\left(\theta^* - \mu + \frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right)}\right)^{\gamma} \\ &\left(\frac{\Phi\left(\frac{\sigma_s}{\tau^2}\left(\theta^* - \mu + \frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right)}{\Phi\left(\frac{\sigma_c}{\tau^2}\left(\theta^* - \mu + \frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right)}\gamma\sigma_c + (1-\gamma)\sigma_s\right) < \frac{\tau^2\sqrt{2\pi}}{\alpha}.\end{aligned} \tag{2.5}$$

It follows from inequality (2.5) that there exists a unique solution for θ^* if private information is very precise compared to public information ($\sigma_c << \tau$ and $\sigma_s << \tau$) and if consumers and sellers are rather similar in terms of their payoffs and the precision parameters of their individual signals.

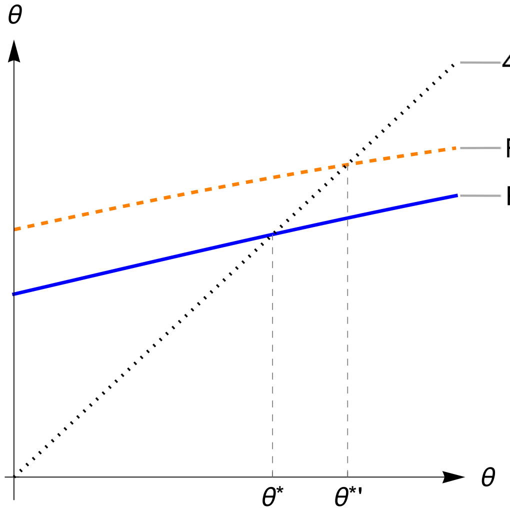
Figure 2.1: Unique and Multiple Equilibria of the Global Game



The numerical values are $\alpha = 1$, $f = 1$, $\mu = 0.9$, $c_c = c_s = 0.4$, $\underline{u} = \underline{\pi} = 1$, $\bar{u} = \bar{\pi} = 1.6$ and $\gamma = 0.5$. The solid blue curve displays the RHS of (2.4) where $\sigma_c = \sigma_s = 0.4$ and $\tau = 0.8$. The dashed (orange) curve displays the RHS' of (2.4) where $\sigma_c' = \sigma_s' = 2$ and $\tau' = 0.6$.

Figure 2.1 illustrates two numerical examples for the right-hand side of (2.4), where consumers and sellers are alike and their participation is equally important for the establishment of the platform. The solid blue curve has only one intersection point with the dotted 45°-line, implying a unique equilibrium value for θ^*. The private information is sufficiently precise for condition (2.5) to be satisfied. In contrast, the numerical values of the dashed (orange) curve violate condition (2.5). The function has three intersection points with the 45°-line, and therefore, multiple equilibrium solutions exist.

Figure 2.2: Unique Equilibrium of the Global Game



The numerical values are $\alpha = 1$, $f = 1$, $\mu = 0.9$, $\tau = 0.8$, $\sigma_c = \sigma_s = 0.4$, $c_c = c_s = 0.4$, $\underline{u} = \underline{\pi} = 1$, and $\bar{u} = 1.6$. The solid blue curve displays the RHS of (2.4) where $\bar{\pi} = 1.6$ and $\gamma = 0.5$. The dashed (orange) curve displays the RHS' of (2.4) where $\bar{\pi}' = 1.5$ and $\gamma' = 0.1$.

Figure 2.2 illustrates the effects of a change in the sellers' payoff $\bar{\pi}$ and their relative importance $1 - \gamma$ on the critical threshold value θ^*. The solid blue curve is identical to the one in Figure 2.1 and serves as a benchmark. The dashed (orange) curve displays a numerical example in which the sellers experience a lower profit $\bar{\pi}'$ by joining the platform and their participation is more decisive for the establishment of the platform $(1 - \gamma' > 1 - \gamma)$. Hence, the threshold value θ^* is above the one in the benchmark scenario. A higher threshold value θ^* implies a higher probability that the true technology value θ is below θ^*. Therefore, the platform is less likely to establish.

The comparative-static effects of consumers' and sellers' utility and profit specifications on the threshold value θ^* are summarized in Lemma 2.1.[5]

Lemma 2.1. *The threshold value* θ^*

(a) is decreasing in $\bar{u}$ *and increasing in* $\underline{u}$ *and* c_c*.*

(b) is decreasing in $\bar{\pi}$ *and increasing in* $\underline{\pi}$ *and* c_s*.*

Proof. See Appendix A2.2 □

Lemma 2.1 outlines the effects of consumers' and sellers' payoff specifications on the threshold value θ^*. If one market side finds it more attractive to join the

[5] We assume $c_c > \frac{1}{2}(\bar{u} - \underline{u})$ and $c_s > \frac{1}{2}(\bar{\pi} - \underline{\pi})$ for all our comparative-static analyses.

platform due to higher utilities or profits, the threshold value is lower. Hence, the probability of the platform's establishment increases. If, however, the offline option is more attractive or the costs of joining are higher, the threshold value is higher. Therefore, the probability of establishment is lower. The effects of the payoffs on the establishment probability are strengthened when the respective market side has the decisive impact on the establishment. These results imply that it is in the platform's interest to lower the users' cost of joining. Therefore, the platform's management should refrain from charging fees during the launch phase of the platform.

Proposition 2.1. *The more (less) attractive it is for users to join the platform, the lower (higher) the threshold value θ^*. The effect on θ^* is strengthened when the respective market side's participation is more decisive for the platform's establishment.*

A further exogenously given parameter affecting the probability of the platform's establishment is the prior expectation μ about the technology value θ. An increase in μ leads to a decrease in the threshold value θ^*.[6] Intuitively, when expectations about the platform's technology value are optimistic, the platform's probability of success is high.

We assume that the platform cannot influence the dispersion σ_c of the consumers' individual signals. The dispersion of consumers' private information results from informal channels, e.g., word-of-mouth, which the platform can hardly influence. The impact of the dispersion parameter σ_c on the threshold value θ^* is captured in Lemma 2.2.

Lemma 2.2. *The threshold value θ^**

(a) is increasing in the dispersion of the consumers' individual signals σ_c if $\theta^* > \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)$.

(b) is decreasing in the dispersion of the consumers' individual signals σ_c if $\theta^* < \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)$.

Proof. See Appendix A2.2 □

For pessimistic prior expectations μ, the threshold value θ^* is increasing in the dispersion of consumers' individual signals. Thus, the platform's establishment is less likely if there is a lot of noise in the consumers' signal. For optimistic expectations,

[6] This statement, referred to as Statement 2.1, is specified in Appendix A2.2.

the effect is reversed. More dispersed consumer signals make the establishment more likely.

So far, our analysis allows us to identify success factors of a platform aiming to establish. In accordance with the empirical evidence, we can explain the establishment and non-establishment of platforms. To derive in-depth managerial implications, we now endogenize the platform's information flows.

2.5 Information Management

Platforms being in the launch phase and trying to establish have the opportunity to strategically influence their success probabilities through their information management. Among others, this management includes advertising strategies, the provision of software test versions or individual consultations. In our model, the lever of the platform's information management is twofold. First, there is the dispersion parameter σ_s of the sellers' idiosyncratic error terms ε_j, i.e., their private information components. Second, there is the parameter τ that determines the dispersion of the distribution of the technology value θ around the public information component μ. As has been pointed out, it is plausible to assume that the platform cannot influence consumers' private information components. This assumption mirrors real-world circumstances, where interested consumers can barely be advised personally. Thus, specific personalized information can be provided to sellers but not to consumers, while all users can be addressed through public communication channels.

The platform's information management can reduce the dispersion σ_s of a seller's private information component ε_j by providing additional personalized information, e.g., via configured software test versions or individual guidance. This reduction in the dispersion of the sellers' idiosyncratic noise terms induces their individual signals to reflect θ more precisely. Similarly, the platform's information management can reduce the dispersion τ of the distribution of the technology value θ around users' joint public information component μ. This can be achieved by providing additional public information, e.g., by non-individualized advertising strategies, and results in a concentration of the realizations of θ around μ. In turn, this information policy results in μ being a better predictor of the true value θ.

Providing additional personalized or public information improves the precision of the respective information component concerning the true value of θ. Thus, additional information leads to a shift between the importance of individual signals and joint expectations for users' joining decision. In the following, we investigate the two channels of information management, i.e., personalized and public information, in detail.[7] Overall, the platform aims to minimize its failure probability

$$P(\theta \leq \theta^*) = \Phi\left(\frac{\theta^* - \mu}{\tau}\right). \tag{2.6}$$

Due to the interrelation of private and public information dispersion, we have to carefully disentangle the specific effects. First, we consider the optimal dispersion of private information σ_s, given the public-information dispersion parameter τ when the cost of this policy is negligible. According to the derivative

$$\frac{\partial P(\theta \leq \theta^*)}{\partial \sigma_s} = \phi\left(\frac{\theta^* - \mu}{\tau}\right)\left(\frac{\frac{d\theta^*}{d\sigma_s}}{\tau}\right), \tag{2.7}$$

the dispersion σ_s enters the failure probability solely through the threshold value θ^*. Therefore, to analyze the sign of (2.7) it is sufficient to consider the sign of $\frac{d\theta^*}{d\sigma_s}$ so that the platform's optimization problem reduces to the minimization of θ^*. By totally differentiating (2.4) we derive:

Lemma 2.3. *The threshold value* θ^*

(a) is increasing in the dispersion of sellers' individual signals σ_s *if* $\theta^* > \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$.

(b) is decreasing in the dispersion of sellers' individual signals σ_s *if* $\theta^* < \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$.

Proof. See Appendix A2.2 □

Lemma 2.3 demonstrates that the prior expectations μ about the platform's technology value are crucial for its management's decision to provide additional personalized information to sellers. Providing sellers with personalized information reduces the dispersion σ_s which is equivalent to increasing the precision $1/\sigma_s$. The platform can lower the threshold value θ^* by increasing the precision of sellers' individual signals if μ is relatively low. On the contrary, increasing the precision of sellers' individual signals undesirably leads to a higher threshold value θ^* if μ is relatively high. In the following, we elaborate on this distinction. We identify three regions of expectations that require different optimal strategies of personalized-information

[7] We calculate the effect of the dispersion parameters by extending the solution techniques used by Bannier and Heinemann (2005) to our setting of a two-sided market.

provision. Let μ_{σ_s} denote the expectation for which the inequalities stated in Lemma 2.3 hold with equality.

First, let us consider the extreme case of negligible private information dispersion, i.e., $\sigma_s = 0$. Then, (2.4) reduces to

$$\theta_0^* = f - \alpha \left(\Phi \left(\frac{\sigma_c}{\tau^2} \left(\mu - \theta_0^* - \frac{\tau\sqrt{\tau^2 + \sigma_c^2}}{\sigma_c} \Phi^{-1} \left(\frac{c_c}{\bar{u} - \underline{u}} \right) \right) \right) \right)^{\gamma} \left(1 - \frac{c_s}{\bar{\pi} - \underline{\pi}} \right)^{1-\gamma}. \tag{2.8}$$

For a negligible dispersion parameter $\sigma_s = 0$, condition (a) in Lemma 2.3 states that the threshold value θ^* is increasing in the dispersion of sellers' individual signals if $\mu < \theta_0^*$. Suppose that prior expectations are low ($\mu < \theta_0^*$) such that, at $\sigma_s = 0$, case (a) in Lemma 2.3 applies. By the definition of Lemma 2.3(a), the left-hand side (LHS) of the inequality is now increasing in σ_s while its RHS is decreasing in σ_s. Hence, the condition stated in Lemma 2.3(a) persists for all $\sigma_s > 0$ so that the critical threshold θ^* monotonically increases in σ_s for $\mu < \theta_0^*$. Therefore, the optimal dispersion of private information is $\sigma_s^* = 0$ so that sellers have perfectly precise information about the platform's technology value. Intuitively, low prior expectations μ dampen the posterior beliefs $E(\theta|x_j)$. To outweigh pessimistic prior beliefs, the platform must avoid that some sellers' private information is additionally biased downwards through highly dispersed signals. Unexpectedly positive realizations of the technology value ($\theta >> \mu$) must rather be reflected as precisely as possible by sellers' individual signals.

Let us now consider the case where $\theta_0^* < \mu$ and, for some $\sigma_s > 0$, case (a) in Lemma 2.3 applies, i.e., $\theta_0^* < \mu < \mu_{\sigma_s}$. Decreasing σ_s decreases the LHS and increases the RHS of the inequality in Lemma 2.3(a) up to the point where it holds with equality, which is denoted by $\tilde{\sigma}_s$.[8] A further reduction of σ_s below $\tilde{\sigma}_s$ would then again increase θ^* by Lemma 2.3(b), reaching its maximum at $\sigma_s = 0$. Thus, for moderately optimistic expectations $\theta_0^* < \mu < \mu_{\sigma_s}$, the optimal dispersion of private information is $\tilde{\sigma}_s$ which yields a threshold value $\theta^* < \theta_0^*$. In this range of expectations, providing private information makes platform establishment more likely.

Finally, we analyze the parameter constellation where $\theta_0^* < \mu$ and, for some $\sigma_s > 0$, case (b) in Lemma 2.3 applies, i.e., $\theta_0^* < \mu_{\sigma_s} < \mu$. Decreasing σ_s increases the LHS and the RHS of the inequality in Lemma 2.3(b). This prevails up to the limit

[8] The implicit solution for $\tilde{\sigma}_s$, referred to as Statement 2.2, is specified in Appendix A2.2.

case $\sigma_s = 0$, where θ^* reaches its maximum so that providing additional personalized information undesirably increases θ^*. Thus, for very optimistic expectations $\theta_0^* < \mu_{\sigma_s} < \mu$, the platform cannot increase its establishment probability by providing sellers with additional personalized information. Intuitively, increasing sellers' private information precision through the provision of additional personalized information would now undesirably shift the trade-off in their joining decisions. Increasing the precision of sellers' private information shifts the focus of their joining decisions toward their individual signals and thus away from the optimistic prior instead of locking in the latter. If the realization of the technology value is unexpectedly low relative to the prior expectation, the platform's likelihood of failure increases.

In summary, when expectations about the technology value are pessimistic, choosing the negligible dispersion $\sigma_s^* = 0$ is optimal and the critical threshold approaches $\theta^* = \theta_0^*$. When expectations are moderately optimistic, it is optimal for the platform to choose the interior solution $\sigma_s^* = \tilde{\sigma}_s$. When expectations are very optimistic, refraining from the provision of additional personalized information is optimal. In the latter two cases, the critical threshold approaches $\theta^* < \theta_0^*$.

Proposition 2.2. *When expectations about the platform's technology value are pessimistic or moderately optimistic (very optimistic), the platform can (cannot) increase its probability of a successful establishment by providing sellers with additional personalized information.*

Let us now consider the platform's optimal provision of public information when the cost of this policy is negligible. Public information is provided to all users through the platform's online presence, e.g., website, social media activities, and informative advertising. Minimization of the platform's failure probability (2.6) with respect to τ yields

$$\frac{\partial P(\theta \leq \theta^*)}{\partial \tau} = \phi\left(\frac{\theta^* - \mu}{\tau}\right)\left(\frac{\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu)}{\tau^2}\right). \tag{2.9}$$

To identify the sign of (2.9), we must consider the sign of the expression $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu)$.

First, we consider the case of low prior expectations, i.e., $\mu < \theta_0^*$. As has been shown, personalized information must be as precise as possible within this range of expectations so that for $\sigma_s = 0$, we have $\theta^* = \theta_0^*$. Totally differentiating (2.4) yields Lemma 2.4 which specifies the sign of $\frac{d\theta^*}{d\tau}$ for for $\mu < \theta_0^*$.

Lemma 2.4. *The threshold value* θ^* *is decreasing in the dispersion* τ *of the public signal if* $\mu < \theta_0^*$.

Proof. See Appendix A2.2 □

Importantly, for expectations $\mu < \theta_0^*$, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ are equal.[9] Thus, for low values of prior expectations μ, the platform cannot lower the threshold value θ^* in order to lower its failure probability by providing additional *public* information. While the platform has an incentive to provide additional *personalized* information to sellers when prior expectations are low, it should focus its strategy on private information channels and refrain from complementing it with additional public information. This is because, for precise public information, the distribution of the technology value would be closely centered around the low expectation. A more dispersed distribution increases the likelihood of extreme realizations and is further improved by precise personalized information to ensure that sellers' signals mirror unexpectedly high realizations of the technology value.

Consider now the case of optimistic prior expectations, $\mu > \theta_0^*$. Within this range of expectations, the platform can decrease the critical threshold θ^* and thus the failure probability by providing additional personalized information to sellers if $\mu < \mu_{\sigma_s}$, while it should refrain from providing additional personalized information if $\mu > \mu_{\sigma_s}$. In both cases it holds that $\theta^* < \theta_0^*$ as the platform management could always reach a threshold value θ_0^* by choosing $\sigma_s = 0$. Note that the effect of τ on the failure probability depends on the sign of the expression $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu)$. Totally differentiating (2.4) yields Lemma 2.5 which specifies the sign of $\frac{d\theta^*}{d\tau}$ for $\mu > \theta_0^*$.

Lemma 2.5. *The threshold value* θ^*

(a) *is decreasing in the dispersion of the public signal* τ *if* $\mu > \theta_0^*$ *and*
$$\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\sigma_c\tau}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)$$
$$+ (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\sigma_s\tau}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) > 0$$

(b) *is increasing in the dispersion of the public signal* τ *if* $\mu > \theta_0^*$ *and*
$$\gamma\frac{(\Phi_s(\cdot))}{(\Phi_c(\cdot))}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\sigma_c\tau}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)$$
$$+ (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\sigma_s\tau}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) < 0$$

where the arguments in $\Phi_s(\cdot)$, $\Phi_c(\cdot)$, $\phi_s(\cdot)$ *and* $\phi_c(\cdot)$ *are defined as in* (2.22).

Proof. See Appendix A2.2 □

[9] The proof is provided within the proof of Lemma 2.4 in Appendix A2.2.

Lemma 2.5 states that the platform can lower the threshold value θ^* by providing additional public information, depending on the level of prior expectations. Let μ_τ denote the expectation for which the inequalities stated in Lemma 2.5 hold with equality. Consider first the case of very optimistic expectations $\mu > \mu_\tau$. For such expectations, case (b) in Lemma 2.5 applies and additional public information reduces the dispersion of the public signal τ and thereby the threshold θ^*. For these expectations, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ are again equal.[10] Therefore, the reduction of θ^* leads to a reduction of the platform's failure probability. In line with the argumentation in the global games literature, we argue that the platform aims to avoid any instability resulting from multiple equilibria that would make clear-cut managerial implications impossible. Therefore, the management's optimal information strategy is conditional on the existence of a unique equilibrium. Consequently, we consider τ as being bounded below by the uniqueness condition (2.5). We denote the critical value that restricts this result to the smallest possible dispersion of public information still ensuring equilibrium uniqueness as τ_{min}:

$$\left(\frac{\Phi\left(\frac{\sigma_c}{\tau_{min}^2}\left(\theta^* - \mu + \frac{\tau_{min}\sqrt{\tau_{min}^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right)}{\Phi\left(\frac{\sigma_s}{\tau_{min}^2}\left(\theta^* - \mu + \frac{\tau_{min}\sqrt{\tau_{min}^2+{\sigma_s}^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right)}\right)^\gamma \left(\frac{\Phi\left(\frac{\sigma_s}{\tau_{min}^2}\left(\theta^* - \mu + \frac{\tau_{min}\sqrt{\tau_{min}^2+{\sigma_s}^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right)}{\Phi\left(\frac{\sigma_c}{\tau_{min}^2}\left(\theta^* - \mu + \frac{\tau_{min}\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right)}\gamma\sigma_c + (1-\gamma)\sigma_s\right) = \frac{\tau_{min}^2\sqrt{2\pi}}{\alpha}. \tag{2.10}$$

Importantly, Lemma 2.5 also implies that, depending on the parameter constellation, there is a range of moderately optimistic prior expectations $\mu \in (\theta_0^*, \mu_\tau)$ for which case (a) in Lemma 2.5 applies and $\frac{d\theta^*}{d\tau} < 0$. Within this range of expectations, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ can differ.[11] Let us define μ'_τ as the expectation where $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu'_\tau) = 0$. For $\mu'_\tau < \mu$, the failure probability can be reduced by providing additional public information. For $\mu \in (\theta_0^*, \mu'_\tau)$, the failure probability cannot be reduced by providing additional public information. Intuitively, if prior expectations about the technology value are low or moderately optimistic, the platform should aim to remain opaque about the value θ. Only when expectations are very optimistic, the platform should aim to be transparent about the technology value.

[10]The proof is provided within the proof of Lemma 2.5 in Appendix A2.2.
[11]The proof is provided within the proof of Lemma 2.5 in Appendix A2.2.

Proposition 2.3. *When expectations about the platform's technology value are pessimistic or moderately optimistic (very optimistic), the platform cannot (can) increase its probability of a successful establishment by providing additional public information.*

Next, we combine these effects with the optimal information policy addressing the sellers individually as summarized in Figure 4.2. For $\mu < \theta_0^*$, a low σ_s shifts consumers' and sellers' expectations toward their individual signals to emphasize unexpectedly high realizations of θ. For moderately high expectations $\mu \in (\theta_0^*, \mu'_\tau)$, the platform management should not provide additional public information. Note that if $\mu_{\sigma_s} < \mu'_\tau$, as illustrated by case (2.1) in Figure 2.3, there is a range of expectations $\mu \in (\mu_{\sigma_s}, \mu'_\tau)$, where the provision of neither type of information can decrease the failure probability, so that platform managers should refrain from further information provision. For very high values $\mu > \mu'_\tau$, a low τ directs consumers' and sellers' expectations toward this highly optimistic technology expectation. Note that if $\mu'_\tau < \mu_{\sigma_s}$ as illustrated by case (2.2) in Figure 2.3, there is a range of expectations $\mu \in (\mu'_\tau, \mu_{\sigma_s})$, where the platform management provides both personalized information to reach $\tilde{\sigma_s}$ and public information to reach τ_{min}.

Proposition 2.4. *The optimal dispersion of personalized and public information predominantly moves into opposite directions so that one dominant channel can be identified. In a possible intermediate range of moderately optimistic expectations, neither personalized nor public information can contribute to a lower failure probability.*

Figure 2.3: Regions of Optimal Information Policy

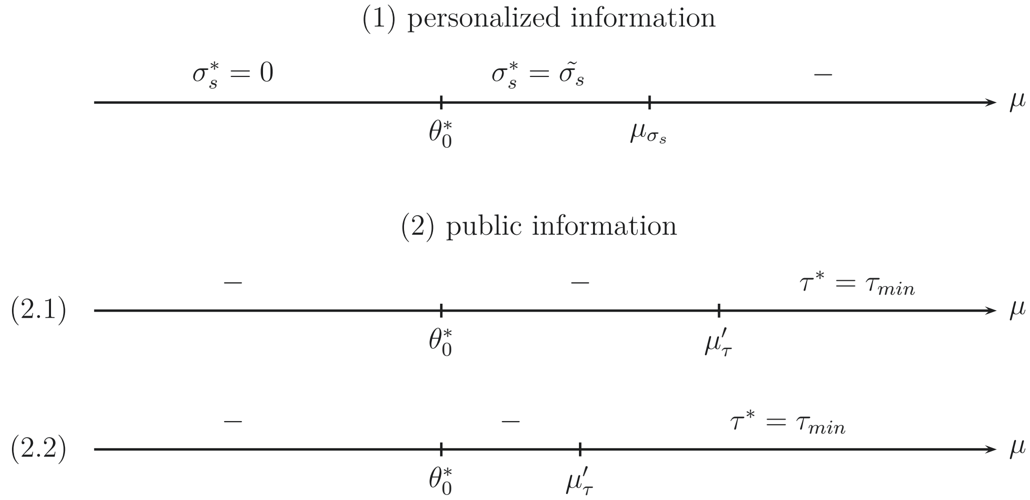
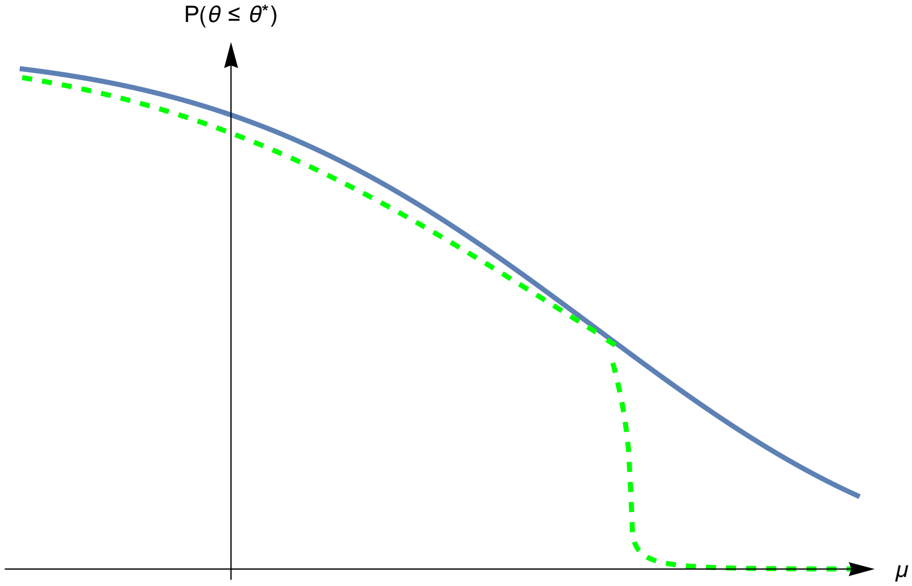


Illustration (1) depicts the optimal provision of personalized information for varying levels of prior expectations. Illustrations (2.1) and (2.2) depict the optimal provision of public information for varying levels of prior expectations. Illustration (2.1) captures the case $\mu_{\sigma_s} < \mu'_\tau$, while (2.2) captures the case $\mu'_\tau < \mu_{\sigma_s}$. The ranges symbolized by $-$ indicate expectations where further information provision is not desirable.

Figure 2.3 summarizes the pattern outlined in Proposition 2.4. To add on this result, consider the Bayesian updating process of consumers' and sellers' prior expectations. Applying its optimal information strategy, the platform steers the trade-off between prior expectations and individual signals. By providing additional information either privately or publicly, it changes the relative weight of these components in users' updated expectations. When prior expectations are very optimistic, the platform should use public information channels. Otherwise, it should use personalized information channels.

Figure 2.4 displays the impact of the platform's optimal information strategy on its failure probability $P(\theta \leq \theta^*)$ compared to the benchmark scenario without any information management.

Figure 2.4: Failure Probability with and without Optimal Information Strategy



The solid blue curve displays the failure probability $P(\theta \leq \theta^*)$ in absence of any information policy based on the second numerical example used in Figure 2.2. The dashed green curve displays the failure probability under the optimal information strategy.

Clearly, the optimal information strategy (dashed green curve) dominates the benchmark scenario (solid blue curve) where the platform refrains from applying any information strategy. The extent of the improvement associated with the outlined information policy substantially differs in μ. While pessimistic market expectations can be slightly offset by personalized information, optimistic market expectations already pave the way for a lower failure probability which can be substantially improved by the provision of public information. Additionally, the relative importance of consumers, measured by γ, narrows managers' leeway to reduce the failure probability for low expectations. If γ is high, and hence the relative importance of sellers is low, the positive impact of providing sellers with personalized information can only enfold moderately.

Overall, these findings yield two important implications for the business strategies of service platforms aiming to establish. First, both types of information policy should be a decisive part of their business strategies. Second, the application of such strategies requires detailed knowledge about potential users' perceptions of platforms' value added.

2.6 Summary and Conclusion

In recent years, many new service platforms have been established, providing consumers and sellers with superior technological opportunities. At the same time, a significant number of platforms has failed to successfully establish. This chapter analyzes a game-theoretical model that explains a platform's probability of success depending on factors such as consumers' and sellers' payoff structures, their expectations about the technology value of the platform, as well as private and public information dispersion. We use a global-game approach to study the consumer and seller decisions on whether to stay offline or to join a platform and interact online. The platform enables more efficient transactions between consumers and sellers if many users on both market sides participate. However, consumers and sellers incur costs when becoming active, and they face uncertainty about the platform's persistence in the market. Consumers and sellers receive individual signals about the platform's technology value composed of publicly and privately available information. They use these signals to form expectations about the participation decisions of the other users and, hence, the platform's establishment probability.

We derive the equilibrium threshold for the technology value above which the platform establishes. The lower the threshold value, the higher the probability of establishment. A unique solution for the threshold value exists if consumers' and sellers' private information is very precise compared to the available public information. A platform establishes if users have strong incentives to go online because of higher utilities or profits compared to the offline option. In contrast, if it is very costly for users to join the platform, the probability of establishment is low. When potential users are optimistic about the technology value, the probability of success is high.

The aforementioned payoffs and market characteristics are from the platform's perspective important, but exogenously given factors. Even more interesting are the variables that the platform's management can strategically control. In our model, the management can influence the probability of success by providing all users with public information and by providing sellers with personalized information. It therefore highlights the important role that platforms attribute to their information policy. It identifies the market's perception of the platform's technology value as the decisive lever to prioritize between private and public information channels. If users are pessimistic about the platform's technology value, the management should focus its policy on personalized information channels to sellers, e.g., through individual appointments and tailored advisory services. For moderately optimistic expectations about the technology value, the provision of additional information does not increase the platform's probability of success, so that no information policy is indicated. If users are very optimistic about the technology value, the platform should use public information channels to increase the probability of being established, e.g., through informative advertising activities.

From a managerial point of view, our main implications are twofold. First, since the optimal information strategy crucially depends on market sentiment, our results call for detailed market research to gain in-depth information about customer expectations and perceptions. Second, to implement these findings into strategical practice, platform managers have to develop versatile information strategies. Our analysis indicates that platforms confronted with pessimistic market expectations should exert significant effort to get in touch with sellers individually in order to counteract negative market sentiment. Otherwise, managers may lock in positive market sentiment by public information campaigns with a broader scope. By addressing both consumers and sellers, they can improve their business model's positive prospects.

A2.1 Properties of Payoff Structure

The theoretical literature on global games (Goldstein and Pauzner, 2004; Bebchuk and Goldstein, 2011) shows that there exists a unique Bayesian equilibrium in the considered type of game if the players' expected payoff differences fulfill the basic properties stated in the seminal paper of Morris and Shin (2003). The resulting threshold equilibrium is characterized by the two critical signals x_c^* and x_s^*, as well as the threshold value θ^*.

In our model, the expected payoff differences between going online and staying offline are given by

$$\Delta_c = \begin{cases} -c_c, & \text{if } \theta + \alpha n^\gamma m^{1-\gamma} \leq f \\ \bar{u} - c_c - \underline{u}, & \text{if } \theta + \alpha n^\gamma m^{1-\gamma} > f \end{cases} \tag{2.11}$$

for the consumers and

$$\Delta_s = \begin{cases} -c_s, & \text{if } \theta + \alpha n^\gamma m^{1-\gamma} \leq f \\ \bar{\pi} - c_s - \underline{\pi}, & \text{if } \theta + \alpha n^\gamma m^{1-\gamma} > f \end{cases} \tag{2.12}$$

for the sellers.

Claim 1 states the properties of the expected payoff differences (2.11) and (2.12) that are required to establish equilibrium existence and uniqueness (Morris and Shin 2003). The subsequent proof shows that the payoff differences indeed fulfill these required properties.

Claim 1. *The expected payoff differences of consumers* (2.11) *and sellers* (2.12) *fulfill the following properties:*

1. *Action Monotonicity:* Both payoff differences, Δ_c and Δ_s are non-decreasing in the proportions n and m of active users.

2. *State Monotonicity:* Δ_c and Δ_s are non-decreasing in θ.

3. *Laplacian State Monotonicity:* There exists a unique threshold value θ^* such that $\int_0^1 \Delta_c^*(\theta^*, n, m, s_s(\cdot))dn = 0$ and $\int_0^1 \Delta_c^*(\theta^*, m, n, s_c(\cdot))dm = 0$ where $s_c(\cdot)$ and $s_s(\cdot)$ are the strategies played by consumers and sellers, respectively.

4. *Uniform Limit Dominance:* There exists a parameter constellation $\underline{\theta} \in \mathbb{R}, \bar{\theta} \in \mathbb{R}$ and $\xi \in \mathbb{R}^+$ such that (1) $\Delta_c \leq -\xi$ and $\Delta_s \leq -\xi$ for all $n, m \in [0, 1]$ and $\theta \leq \underline{\theta}$ and (2) $\Delta_c > \xi$ and $\Delta_s > \xi$ for all $n, m \in [0, 1]$ and $\theta \geq \bar{\theta}$.

5. *Finite Expectations of Signals:* The distribution of the random noise variable must be integrable.

Proof of Claim 1.

Conditions 1 to 5 hold by the following arguments.

1. *Action Monotonicity:*

$$\Delta_c = \begin{cases} -c_c, & \text{if } n \leq \frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}, m \leq \frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}} n^{\frac{\gamma}{1-\gamma}}} \\ \bar{u} - c_c - \underline{u}, & \text{if } n > \frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}, m > \frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}} n^{\frac{\gamma}{1-\gamma}}} \end{cases} \tag{2.13}$$

$$\Delta_s = \begin{cases} -c_s, & \text{if } n \leq \frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}, m \leq \frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}} n^{\frac{\gamma}{1-\gamma}}} \\ \bar{\pi} - c_s - \underline{\pi}, & \text{if } n > \frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}, m > \frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}} n^{\frac{\gamma}{1-\gamma}}} \end{cases} \tag{2.14}$$

Based on our assumptions, Δ_c and Δ_s are monotonically increasing in n and m.

2. *State Monotonicity:*

$$\Delta_c = \begin{cases} -c_c, & \text{if } \theta \leq f - \alpha n^{\gamma} m^{1-\gamma} \\ \bar{u} - c_c - \underline{u}, & \text{if } \theta > f - \alpha n^{\gamma} m^{1-\gamma} \end{cases} \tag{2.15}$$

$$\Delta_s = \begin{cases} \underline{\pi} - c_s - \underline{\pi} = -c_s, & \text{if } \theta \leq f - \alpha n^{\gamma} m^{1-\gamma} \\ \bar{\pi} - c_s - \underline{\pi}, & \text{if } \theta > f - \alpha n^{\gamma} m^{1-\gamma} \end{cases} \tag{2.16}$$

Based on our assumptions, Δ_c and Δ_s are monotonically increasing in θ.

3. *Laplacian State Monotonicity:*

First, consider the consumers' payoff difference:

$$\int_0^{\frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}} -c_c dn + \int_{\frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}}}^{1} (\bar{u} - c_c - \underline{u}) dn = 0 \tag{2.17}$$

For $\theta = f$ the LHS of expression (2.17) is positive, for $\theta = f - \alpha m^{1-\gamma}$ it is negative. For values of θ in between, the LHS of (2.17) integrates to

$$\frac{(f-\theta)^{\frac{1}{\gamma}}}{\alpha^{\frac{1}{\gamma}} m^{\frac{1-\gamma}{\gamma}}} \underbrace{(\underline{u} - \bar{u})}_{<0} + \bar{u} - c_c - \underline{u}, \tag{2.18}$$

which is monotonically increasing in θ. Next, consider the sellers' payoff difference:

$$\int_{0}^{\frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}}n^{\frac{\gamma}{1-\gamma}}}} -c_s dm + \int_{\frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}}n^{\frac{\gamma}{1-\gamma}}}}^{1} (\bar{\pi} - c_s - \underline{\pi}) dm = 0 \tag{2.19}$$

For $\theta = f$ the LHS of expression (2.19) is positive, for $\theta = f - \alpha n^{\gamma}$ it is negative. For values of θ in between, the LHS of (2.19) integrates to

$$\frac{(f-\theta)^{\frac{1}{1-\gamma}}}{\alpha^{\frac{1}{1-\gamma}}n^{\frac{\gamma}{1-\gamma}}} \underbrace{(\underline{\pi} - \bar{\pi})}_{<0} + \bar{\pi} - c_s - \underline{\pi}, \tag{2.20}$$

which is monotonically increasing in θ.

4. *Uniform Limit Dominance:*

In the limit case of $\theta = \overline{\theta} = f$ it holds that $\Delta_c, \Delta_s > 0 \; \forall \; m, n$. In the opposite limit case $\theta = \underline{\theta} = f - \alpha$ it holds that $\Delta_c, \Delta_s < 0 \; \forall \; m, n$. Therefore, it follows from (2.11) and (2.12) that $\xi = \min\{\bar{u} - c_c - \underline{u}; \bar{\pi} - c_s - \underline{\pi}\}$.

5. *Finite Expectations of Signals:*

This immediately follows from the assumption of the normally distributed noise variable. □

A2.2 Proofs of Statements and Lemmas

Proof of Lemma 2.1.
The implicit solution equation from (2.4) reads

$$\begin{aligned} 0 =& f - \alpha \left(\Phi \left(\frac{\sigma_c}{\tau^2} \left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2 + \sigma_c^2}}{\sigma_c} \Phi^{-1} \left(\frac{c_c}{\bar{u} - \underline{u}} \right) \right) \right) \right)^{\gamma} \\ & \left(\Phi \left(\frac{\sigma_s}{\tau^2} \left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2 + \sigma_s^2}}{\sigma_s} \Phi^{-1} \left(\frac{c_s}{\bar{\pi} - \underline{\pi}} \right) \right) \right) \right)^{1-\gamma} - \theta^* \; . \end{aligned} \tag{2.21}$$

To derive the comparative-static effects of θ^*, we use the implicit function theorem. The partial derivative of the RHS of (2.21) with respect to θ^* is

$$\frac{\partial RHS(2.21)}{\partial \theta^*} = \frac{\alpha}{\tau^2}\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\left(\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c + (1-\gamma)\phi_s(\cdot)\sigma_s\right) - 1 \tag{2.22}$$

where

$$\Phi_c(\cdot) \equiv \Phi\left(\frac{\sigma_c}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right),$$

$$\Phi_s(\cdot) \equiv \Phi\left(\frac{\sigma_s}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right),$$

$$\phi_c(\cdot) \equiv \phi\left(\frac{\sigma_c}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right),$$

$$\phi_s(\cdot) \equiv \phi\left(\frac{\sigma_s}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right).$$

It follows from (2.5) that $\frac{\partial RHS(2.21)}{\partial \theta^*} < 0$ holds.
First, the consumers' side is considered in (a). The partial derivatives of the RHS of (2.21) read

$$\frac{\partial RHS(2.21)}{\partial \bar{u}} = -\alpha\gamma\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{1-\gamma}\phi_c(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\frac{c_c}{\phi\left(\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)(\bar{u}-\underline{u})^2} < 0, \tag{2.23}$$

$$\frac{\partial RHS(2.21)}{\partial \underline{u}} = \alpha\gamma\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{1-\gamma}\phi_c(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\frac{c_c}{\phi\left(\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)(\bar{u}-\underline{u})^2} > 0, \tag{2.24}$$

$$\frac{\partial RHS(2.21)}{\partial c_c} = \alpha\gamma\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{1-\gamma}\phi_c(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\frac{1}{\phi\left(\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)(\bar{u}-\underline{u})} > 0. \tag{2.25}$$

By using the partial derivatives (2.22) to (2.25) we obtain the total differentials

$$\frac{d\theta^*}{d\bar{u}} < 0\,, \quad \frac{d\theta^*}{d\underline{u}} > 0\,, \quad \frac{d\theta^*}{dc_c} > 0\,.$$

Second, the sellers' side is considered in (b).
The partial derivatives of the RHS of (2.21) read

$$\frac{\partial RHS(2.21)}{\partial \bar{\pi}} = -\alpha(1-\gamma)\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\phi_s(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\frac{c_s}{\phi\Big(\Phi^{-1}\Big(\frac{c_s}{\bar{\pi}-\underline{\pi}}\Big)\Big)(\bar{\pi}-\underline{\pi})^2} < 0, \tag{2.26}$$

$$\frac{\partial RHS(2.21)}{\partial \underline{\pi}} = \alpha(1-\gamma)\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\phi_s(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\frac{c_s}{\phi\Big(\Phi^{-1}\Big(\frac{c_s}{\bar{\pi}-\underline{\pi}}\Big)\Big)(\bar{\pi}-\underline{\pi})^2} > 0, \tag{2.27}$$

$$\frac{\partial RHS(2.21)}{\partial c_s} = \alpha(1-\gamma)\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\phi_s(\cdot)\frac{\tau\sqrt{\tau^2+\sigma_s^2}}{\sigma_s}\frac{1}{\phi\Big(\Phi^{-1}\Big(\frac{c_s}{\bar{\pi}-\underline{\pi}}\Big)\Big)(\bar{\pi}-\underline{\pi})} > 0. \tag{2.28}$$

By using the partial derivatives (2.22) and (2.26) to (2.28) we obtain the total differentials

$$\frac{d\theta^*}{d\bar{\pi}} < 0\,, \quad \frac{d\theta^*}{d\underline{\pi}} > 0\,, \quad \frac{d\theta^*}{dc_s} > 0\,.$$

□

Proof of Statement 2.1.
Statement 2.1 claims that $\frac{d\theta^*}{d\mu} < 0$. The partial derivative of (2.21) with respect to μ is

$$\frac{\partial RHS(2.21)}{\partial \mu} = -\frac{\alpha}{\tau^2}\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\left(\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c + (1-\gamma)\phi_s(\cdot)\sigma_s\right) < 0. \tag{2.29}$$

By using the partial derivatives (2.22) and (2.29) we obtain the total differential $\frac{d\theta^*}{d\mu} < 0$. □

Proof of Lemma 2.2.

The partial derivative of (2.21) with respect to σ_c is

$$\frac{\partial RHS(2.21)}{\partial \sigma_c} = -\alpha\gamma \left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{1-\gamma} \phi_c(\cdot) \left(\frac{1}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right). \tag{2.30}$$

If it holds that $\theta^* > \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)$, then $\frac{\partial RHS(2.21)}{\partial \sigma_c} > 0$.
If it holds that $\theta^* < \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)$, then $\frac{\partial RHS(2.21)}{\partial \sigma_c} < 0$.
By using the partial derivatives (2.22) and (2.30) we obtain the total differentials

$$\frac{d\theta^*}{d\sigma_c} > 0 \qquad \text{for} \qquad \theta^* > \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)$$
$$\frac{d\theta^*}{d\sigma_c} < 0 \qquad \text{for} \qquad \theta^* < \mu - \frac{\tau\sigma_c}{\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right).$$

□

Proof of Lemma 2.3.
The partial derivative of (2.21) with respect to σ_s is

$$\frac{\partial RHS(2.21)}{\partial \sigma_s} = -\alpha(1-\gamma) \left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma} \phi_s(\cdot) \left(\frac{1}{\tau^2}\left(\mu - \theta^* - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right). \tag{2.31}$$

If it holds that $\theta^* > \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$, then $\frac{\partial RHS(2.21)}{\partial \sigma_s} > 0$.
If it holds that $\theta^* < \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$, then $\frac{\partial RHS(2.21)}{\partial \sigma_s} < 0$.
By using the partial derivatives (2.22) and (2.31) we obtain the total differentials

$$\frac{d\theta^*}{d\sigma_s} > 0 \qquad \text{for} \qquad \theta^* > \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$$
$$\frac{d\theta^*}{d\sigma_s} < 0 \qquad \text{for} \qquad \theta^* < \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right).$$

□

Proof of Statement 2.2.
The implicit solution for $\tilde{\sigma_s}$ follows from equating the condition in Lemma 2.3, i.e., $\theta^* = \mu - \frac{\tau\sigma_s}{\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)$, and inserting it in the implicit function for the

threshold value (2.4). This yields

$$\mu - \frac{\tau\tilde{\sigma_s}}{\sqrt{\tau^2+\tilde{\sigma_s}^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right) =$$
$$f - \alpha\left(\Phi\left(\frac{\sigma_c}{\tau^2}\left(\frac{\tau\tilde{\sigma_s}^2}{\sqrt{\tau^2+\tilde{\sigma_s}^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right) - \frac{\tau\sqrt{\tau^2+\sigma_c^2}}{\sigma_c}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right)\right)^{\gamma}$$
$$\left(\Phi\left(\left(\frac{\tilde{\sigma_s}^2}{\tau\sqrt{\tau^2+\tilde{\sigma_s}^2}} - \frac{\sqrt{\tau^2+\tilde{\sigma_s}^2}}{\tau}\right)\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right)^{1-\gamma}.$$

□

Proof of Lemma 2.4.

The partial derivative of (2.21) with respect to τ is

$$\frac{\partial RHS(2.21)}{\partial\tau} = -\frac{2\alpha}{\tau^3}\left(\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\right)^{-\gamma}\left(\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right)\right.$$
$$\left. +(1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\tau\sigma_s}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right)\right). \tag{2.32}$$

If it holds that $\left(\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right) + (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\tau\sigma_s}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) < 0$, then $\frac{\partial RHS(2.21)}{\partial\tau} > 0$, and by (2.22), $\frac{d\theta^*}{d\tau} > 0$.
If it holds that $\left(\gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right) + (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\tau\sigma_s}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) > 0$, then $\frac{\partial RHS(2.21)}{\partial\tau} < 0$, and by (2.22), $\frac{d\theta^*}{d\tau} < 0$. For pessimistic prior expectations $\mu < \theta_0^*$ where $\sigma_s = 0$ and thus $\theta^* = \theta_0^*$ this condition reduces to $\theta_0^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right) > 0$. This inequality holds for any $\mu < \theta_0^*$ so that $\frac{d\theta^*}{d\tau} < 0$ and Lemma 2.4 directly follows.
Based on these arguments, it must hold for any $\mu < \theta_0^*$ that $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu) < 0$. Thus, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ are equal. □

Proof of Lemma 2.5.

By using the partial derivatives (2.22) and (2.32) we obtain the total differentials proving Lemma 2.5:

$$\frac{d\theta^*}{d\tau} < 0 \quad \text{for} \quad \begin{aligned} 0 < \quad & \gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right) \\ & + (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\tau\sigma_s}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) \end{aligned}$$

proves Lemma 2.5(a), while

$$\frac{d\theta^*}{d\tau} > 0 \quad \text{for} \quad \begin{aligned} 0 > \quad & \gamma\frac{\Phi_s(\cdot)}{\Phi_c(\cdot)}\phi_c(\cdot)\sigma_c\left(\theta^* - \mu + \frac{\tau\sigma_c}{2\sqrt{\tau^2+\sigma_c^2}}\Phi^{-1}\left(\frac{c_c}{\bar{u}-\underline{u}}\right)\right) \\ & + (1-\gamma)\phi_s(\cdot)\sigma_s\left(\theta^* - \mu + \frac{\tau\sigma_s}{2\sqrt{\tau^2+\sigma_s^2}}\Phi^{-1}\left(\frac{c_s}{\bar{\pi}-\underline{\pi}}\right)\right) \end{aligned}$$

proves Lemma 2.5(b).

It follows from the condition on Lemma 2.5(a) that for moderately optimistic expectations $\theta^* < \theta_0^* < \mu < \mu_\tau$, it must hold that $\frac{d\theta^*}{d\tau} < 0$ and $\mu > \theta^*$ so that $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu) \gtreqless 0$. Thus, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ can differ for this range of expectations. If $\mu < \mu'_\tau$ which is implicitly defined by $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu'_\tau) = 0$, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ are negative. If $\mu > \mu'_\tau$, the sign of (2.9) is positive while the sign of $\frac{d\theta^*}{d\tau}$ is negative.

It follows from the condition on Lemma 2.5(b) that for very optimistic expectations $\theta^* < \theta_0^* < \mu_\tau < \mu$, it must hold that $\frac{d\theta^*}{d\tau} > 0$ and $\mu > \theta^*$ so that $\frac{d\theta^*}{d\tau}\tau - (\theta^* - \mu) > 0$. Thus, the signs of (2.9) and $\frac{d\theta^*}{d\tau}$ are equal for this range of expectations. □

3 Welfare Effects of Platforms' Exclusivity Clauses[†]

Abstract

Consumers are often active on multiple digital platforms, while gatekeeper platforms can force sellers contractually to use one platform exclusively. This chapter considers the effects of such exclusivity clauses on consumers, sellers, and platforms in a platform duopoly with a seller membership fee. A setting with partially multihoming consumers and sellers is compared to one with partially multihoming consumers and singlehoming sellers. It is shown that exclusivity clauses predominantly harm total welfare. Consumers suffer if sellers are exclusive on one platform, whereas platforms and sellers benefit from exclusivity clauses under certain conditions. In an environment with exclusivity clauses, when strong cross-group benefits and weak platform differentiation result in fierce price competition, exclusivity clauses can be welfare-enhancing.

Keywords: Platform competition, two-sided markets, multihoming, exclusive contracts

JEL classification: D43, D47, D62, L13, L22

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3.1 Introduction

Digital companies have extended and intensified their presence in people's lives in recent decades. The business model of many of these companies is to connect two sides of a market, that is, the consumer and the seller side. Firms with such platform business models are *Airbnb*, *Booking.com*, *Uber*, *Lift*, *Lieferando*, and *Delivery Hero*, to name a few. Consumer participation on a platform requires only a few clicks. Joining a platform as a consumer is often for free, for instance, shopping platforms like *Otto.de* and *Zalando*, or online job boards such as *Monster* or *Indeed*. Therefore, many consumers are active on more than one platform. Joining a platform as a seller involves more bureaucratic and technical effort. Additionally, platforms can contractually establish and enforce an exclusivity clause on the seller side. Some platforms have reached such a strong intermediation position that sellers' economic success depends on these so-called gatekeepers (European Commission, 2023). Depending on the market under consideration, sellers may be forced to be exclusive on one platform.

In the literature, platform users, who join one platform exclusively, are categorized as singlehoming. Users who join more than one platform are considered to be multihoming (Rochet and Tirole, 2003). Partial multihoming occurs when some users multihome whereas the remaining users singlehome (Bakos and Halaburda, 2020). In digital markets, multihoming is usual on the consumer side. Whether sellers singlehome or multihome depends on the platforms' contractual terms. The content platform *Twitch*, the e-commerce platform *Alibaba*, and the food delivery platform *Meituan* used such exclusivity clauses (Global Times, 2021; AFK Gaming, 2022). Also, *Spotify* provides, and *Tencent* provided exclusive content for their consumers (Digital Music News, 2021). Exclusivity clauses are often criticized by regulators. For instance, the Chinese regulators banned exclusive agreements for music content (Reuters, 2022). Also, the European regulators consider the lack of multihoming as a threat to fair competition, and emphasize that multihoming should be facilitated (European Parliament and Council, 2022).

In light of this, it is crucial to understand the platforms' incentive to offer exclusivity clauses and the implications it has for the other market participants. This chapter examines for whom exclusivity clauses issued to sellers are beneficial or harmful. It considers the effects of such exclusivity clauses on the consumer and seller surplus, platforms' profits, and total welfare. To do so, we consider a duopoly platform market in which sellers pay a membership fee to participate. Platforms set their fees and consumers and sellers decide which platform(s) they join. We derive the market outcome under two settings: one in which sellers can choose to be active on both platforms, and another one in which they are required to be exclusive on a single platform. The outcomes of these two settings are then compared to assess the implications of exclusivity clauses.

We find that seller exclusivity clauses predominantly reduce total welfare. Fewer sellers join each platform in the presence of an exclusivity clause compared to a setting without such a clause. The seller membership fee is higher in an environment with exclusivity clauses. Thus, platforms offer exclusive contracts whenever the higher membership fee outweighs the additional sellers that join the platform in a non-exclusive setting. When the platform enforces seller exclusivity, lower seller participation results in higher consumer participation. Many consumers counteract the utility loss caused by the lower number of sellers they would meet on a single platform by joining both platforms. In the aggregate, consumers incur more costs of joining platforms. Thus, consumers unambiguously suffer from exclusivity clauses. Sellers particularly suffer from exclusivity clauses if consumers have few incentives to join both platforms. In this case, sellers cannot react to low consumer participation with higher seller participation. Additionally, the seller fee in the exclusive setting becomes expensive if many consumers are exclusive on a platform. Therefore, sellers usually prefer a setting without exclusivity clauses. However, when platforms' competition on membership fees is fierce in the exclusive setting, sellers may benefit from exclusivity clauses. Although the membership fee is higher than in the non-exclusive outcome, the difference is small. Consequently, in the aggregate, sellers incur lower costs of joining platforms because, in the exclusive setting, all of them only join a single platform. Indeed, exclusivity clauses can enhance welfare in this scenario driven by the positive effect on the seller surplus.

The remainder of the chapter is structured as follows: Section 3.2 provides an overview of the related literature. Section 3.3 introduces the model setup. Section 3.4 considers the market outcomes without exclusivity clauses. In Section 3.5, the platforms enforce exclusivity on the seller side. The equilibrium outcomes are derived when sellers singlehome and consumers partially multihome. A comparison of the scenarios is presented in Section 3.6. Finally, Section 3.7 summarizes the findings and concludes the chapter.

3.2 Related Literature

This model builds on a large body of literature on two-sided markets (Caillaud and Jullien, 2003; Evans, 2003; Rochet and Tirole, 2003). Platforms in this mode are horizontally differentiated and cross-group benefits connect the consumer and seller sides. Armstrong (2006) developed this framework with membership fees on both market sides. A widely used assumption is that consumers join a single platform whereas sellers join more than one platform (Wright and Armstrong, 2007; Brühn and Götz, 2016). The so-called competitive bottleneck setting suits markets where consumers buy a hardware product to join the platform. In digital markets, joining a platform does not require the purchase of hardware. Thus, multihoming becomes more relevant on the consumer side (Choi, 2010; Athey et al., 2018; Pires, 2020; Jeitschko and Tremblay, 2020; C. Liu et al., 2023). Bakos and Halaburda (2020) endogenize the multihoming decision on the consumer and seller side in the Hotelling setting and analyze the effects on participants' fees. We adopt the endogenous consumer decision and extend the analysis by considering the change that occurs when switching from a competitive bottleneck setting to a setting with partially multihoming on both sides. Additionally, we examine the consumer and seller surplus as well as the total welfare.

This chapter aims to extend the literature on exclusivity clauses. A part of the literature focuses on questions concerning platforms' market entry. Exclusivity clauses can deter the entry of a new platform when they are proposed by an incumbent platform (Doganoglu and Wright, 2009; Chica et al., 2021). If they are offered by an entrant platform, they can resolve the chicken-and-egg problem of a platform market (Lee, 2013). Belleflamme and Peitz (2019) consider the effect of seller exclusivity clauses in a well-established market with two dominant platforms. They compare the market environments with singlehoming consumers and sellers to an environment with partially multihoming sellers regarding membership fees, platforms' profits, and the surplus of consumers and sellers. A set of possible market outcomes occurs. Shifting toward multihoming sellers may benefit consumers, sellers, and platforms. In other parameter constellations, platforms benefit from exclusive sellers, whereas at least one of the participating sides is worse off. In contrast, if platforms prefer multihoming sellers, consumers or sellers benefit from singlehoming sellers. This chapter considers the welfare effects of exclusivity clauses on the seller side, building on the framework of Belleflamme and Peitz. However, in contrast, we assume that consumers are partially multihoming in both environments, which describes digital markets better. The endogenous consumer decision on multihoming enables us to consider the effect of seller exclusivity clauses on the consumer participation behavior.

Other papers examine the seller type that should be targeted by the platform with exclusivity clauses. Carroni et al. (2023) study the contractual choices of superstar content providers (equivalent to our sellers). Exclusive deals with a superstar content provider have positive spillover effects on smaller content providers. They conclude that banning exclusivity contracts may harm welfare. Ishihara and Oki (2021) study the choice of exclusivity clauses of a monopolistic content provider in a situation with partial multihoming on both market sides. The content provider chooses the fraction of exclusive content provided to platforms by considering its effect on the bargaining power of the platforms. In contrast to these papers, we assume that all sellers are equally valuable to platforms.

Exclusivity clauses can be linked to price discounts. Saruta (2022) studies the effect of exclusive contracts in a duopoly platform market, where only one platform can offer exclusive contracts. Sellers with exclusive contracts enter the platform for free. Saruta (2022) derives the optimal number of exclusive sellers and considers the welfare effects in the two limit cases where platforms offer exclusive contracts to all or no sellers. The closely related paper of Shekhar (2022) considers price discrimination in a setting with partially multihoming sellers and singlehoming consumers. Platforms set different prices for singlehoming and multihoming sellers. Price discrimination is profitable for platforms if the group of either multihoming or singlehoming sellers is particularly large. In our setting, price discrimination does not occur if sellers are partially multihoming.

Cong et al. (2022) shed light on asymmetric platforms. Similar to our setting, they consider platform markets without a fee for consumers. Contrary to us, they assume asymmetric intrinsic values for sellers to join a platform and normalize the network effects and consumers' transportation costs. They find that exclusivity clauses make a strong platform to compete less aggressively, while they make a weak platform to compete more aggressively. They find that exclusivity clauses can benefit society when a strong platform introduces them.

3.3 Model Setup

Consider a duopoly platform market in which platforms connect consumers and sellers. These platforms generate their profits through membership fees paid by the sellers who join them. The two platforms are horizontally differentiated from each other by users' preferences. The preferences of consumers c and sellers s are uniformly distributed on the Hotelling lines $x_c \sim U[0,1]$ and $x_s \sim U[0,1]$. The platforms are located at the two extremes of these Hotelling lines. Thus, platform A is located at $x_g^A = 0$ and platform B is located at $x_g^B = 1$ on the consumer and seller side $g = \{c, s\}$.

When a consumer joins a platform, the consumer obtains a standalone value $r_c > 0$ and a cross-group benefit $\beta_c > 0$ for each seller on the platform. The standalone value represents the utility that the platform provides. For example, this could be content generated by the platform that interests consumers. The cross-group benefit reflects a consumer's utility gain from each interaction with a seller. The number of sellers joining platform $i = \{A, B\}$ is denoted by n_s^i. Therefore, a consumer's gross utility from joining platform i is captured by $u_c^i = r_c + n_s^i \beta_c$. Based on observations of shopping platforms such as *Otto.de* and *Zalando*, consumers in our model do not pay a fee to be active on the platform. However, consumers have a linearly increasing mismatching utility loss $\tau_c > 0$ when joining a platform. This represents the disutility that consumers experience when the platform does not perfectly match their tastes. If a consumer joins platform A, which is located at $x_c^A = 0$, the net utility, accounting for the mismatching disutility, is $u_c^A - \tau_c x_c$. Respectively, a consumer who joins platform B, located at $x_c^B = 1$, obtains the net utility $u_c^B - \tau_c(1 - x_c)$. A consumer who joins the two platforms obtains the net utility $u_c^M = 2r_c + \beta_c - \tau_c$. This multihoming consumer enjoys the standalone values of using both platforms and experiences the disutility of mismatching for the entire length of the line segment. If sellers can also join both platforms, some consumers and sellers meet each other on both platforms. We assume that neither consumers nor sellers derive additional value from meeting a user of the opposite type a second time. This is a reasonable assumption, as consumers do not typically buy the same product twice. Therefore, a multihoming consumer only derives the cross-group benefit of meeting all sellers once. Thus, the cross-group benefit β_c of a multihoming consumer is multiplied by the mass of sellers, which is normalized to one.

Sellers' utilities are determined similarly. A seller derives the standalone value $r_s > 0$ from joining a platform. The cross-group benefit $\beta_s > 0$ is the profit that a seller makes from each consumer that they meet on the platform, where the number of consumers on platform i is denoted by n_c^i. On the seller side, platforms charge a membership fee m_s^i. Therefore, a seller's gross utility from joining platform i is $u_s^i = r_s + n_c^i \beta_s - m_s^i$. A seller also incurs a differentiation cost $\tau_s > 0$ to join the closest platform. This cost captures the setup cost to be compatible with a platform's system. Therefore, the net utility of joining platform A $u_s^A - \tau_s x_s$ or joining platform B $u_s^B - \tau_s(1 - x_s)$ includes the mismatching disutility that a seller experiences when joining a platform. A seller who joins two platforms obtains the net utility $u_s^M = 2r_s + \beta_s - (m_s^i + m_s^j) - \tau_s$. Although this multihoming seller benefits from joining both platforms, the membership fee must be paid twice.

The optimal pricing strategy of platforms and the users' decision about which platform(s) to join are derived from a two-stage game. The timing of the game is as follows:

Stage 1. Platform i sets seller membership fee m_s^i.

Stage 2. Consumers and sellers simultaneously decide which platform(s) they join.

The game is solved in two variations. In Section 3.4, the model is solved under the assumption that sellers have the option to multihome, meaning there are no exclusivity clauses in place. In Section 3.5, sellers are required to be exclusive on one platform.

Throughout the chapter, it is assumed that the differentiation variables outweigh the cross-group benefits, i.e., $\tau_c\tau_s > \beta_c\beta_s$. This assumption guarantees the coexistence of two platforms in the market due to an adequate level of differentiation. This assumption also ensures that the second-order conditions are satisfied in both variations of the model.

3.4 Platform Competition without Exclusivity Clauses

We begin our analysis by deriving the market outcomes under the assumption that platforms do not propose exclusivity clauses to sellers. In this scenario, sellers can choose to be active on one platform or both platforms. Thus, both consumers and sellers can multihome.[1] To derive the subgame perfect equilibrium the game is solved through backward induction.

In the second stage, users decide on their participation on the platform. Consumers can either join one platform or two platforms. Therefore, they consider the net utility of joining platform A, platform B, or both to choose the option with

[1]The game follows Bakos and Halaburda (2020). In the game at hand, however, consumers do not pay a membership fee to access the platform.

the highest net utility. An indifferent consumer derives the same utility from two options. The consumer who is indifferent between joining platform A in addition to platform B or staying exclusive on platform B is located at x_c^{BA}. Therefore, every consumer located on the left side of x_c^{BA} on the Hotelling line joins platform A. Because consumers are distributed uniformly, the number of consumers joining platform A is equal to the location of the indifferent consumer, i.e., $n_c^A = x_c^{BA}$. The last consumer joining platform B in addition to platform A is located at x_c^{AB}. Consumers located to the right side of the indifferent consumer at x_c^{AB} will join platform B. Consequently, the demand function for platform B is $n_c^B = 1 - x_c^{AB}$. One can observe multihoming consumers if there is an overlap between the location of the two indifferent consumers. Formally, the existence of mulithoming and singlehoming consumers requires that $0 < x_c^{AB} < x_c^{BA} < 1$. Consumers whose preferences are between 0 and x_c^{AB} singlehome on platform A. Those located between x_c^{AB} and x_c^{BA} use both platforms, so they multihome. Those located between x_c^{BA} and 1 singlehome on platform B. The number of active consumers on platform i where $i, j = A, B$ and $i \neq j$ is

$$n_c^i = \frac{r_c + (1 - n_s^j)\beta_c}{\tau_c}. \tag{3.1}$$

The fraction of sellers who choose to be exclusive on platform i is equal to $(1 - n_s^j)$. Therefore, the platform attracts more consumers if it hosts more exclusive sellers. This effect is intensified when the cross-group effect β_c that consumers obtain from meeting sellers is greater. The number of consumers on a platform is also higher when consumers obtain a larger standalone value r_c from joining the platform. However, fewer consumers join a platform when the mismatching disutility of consumers τ_c is higher. To examine seller participation, the locations of the indifferent sellers are considered analogously to the consumer side. Then, the number of sellers on each platform is determined by the locations of the indifferent sellers. The number of sellers on platform i yields

$$n_s^i = \frac{r_s + (1 - n_c^j)\beta_s - m_s^i}{\tau_s}, \tag{3.2}$$

where $(1 - n_c^j)$ is the number of exclusive consumers on platform i. Hence, the more exclusive consumers a platform hosts and the lower the membership fee m_s^i is, the more sellers the platform attracts. Solving (3.1) and (3.2) yields the number of consumers

$$n_c^i = \frac{\tau_s(r_c + \beta_c) - \beta_c(r_s - m_s^j + \beta_s)}{\tau_c\tau_s - \beta_c\beta_s},$$

and the number of sellers

$$n_s^i = \frac{\tau_c(r_s - m_s^i + \beta_s) - \beta_s(r_c + \beta_c)}{\tau_c\tau_s - \beta_c\beta_s}$$

on platform i depending on the seller membership fees.

In the first stage, the platforms determine the optimal membership fee. To do so, platform i maximizes its profit function $\pi_i = (m_s^i - c_s)n_s^i$ with respect to the seller membership fee m_s^i. We assume that both platforms have an equal cost of c_s per seller. Therefore, in equilibrium, they choose the symmetric strategy $i = j$. The membership fee is

$$m_s^{NE} = \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2\tau_c} + c_s, \tag{3.3}$$

where the superscript NE denotes the equilibrium outcome if sellers are not required to stay exclusive on one platform. The variable h_s denotes the standalone value of joining a platform net of cost, i.e., $h_s \equiv r_s - c_s$. The higher the net standalone value for sellers, the higher their fee. As a benchmark result, we consider the case in which the two market sides are not interconnected by neglecting the cross-group benefits ($\beta_c = \beta_s = 0$). When platforms set the seller fee independently of the effect on the consumer side, it is equal to the monopoly price $(1/2)(r_s + c_s)$. By analyzing how the consumer side affects the seller fee, we find that the fee rises when more consumers choose to stay exclusive on one platform. According to equation (3.1), the number of consumers decreases as their mismatching disutility τ_c increases and their cross-group benefit β_c decreases. Consequently, more consumers stay exclusive on one platform. Concurrently, the increase in τ_c and a decrease in β_c lead to an increase in the seller membership fee.

In equilibrium, the seller participation is

$$n_s^{NE} = \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)},$$

where the denominator is positive given the assumption that $\tau_c\tau_s > \beta_c\beta_s$. The numerator shows that the number of sellers increases in the net standalone value h_s. Variables that lead to more consumer participation (high r_c, high β_c, low τ_c)

negatively affect the seller participation. This indicates that a larger participation on the consumer side leads to a smaller participation on the seller side. A change in seller participation results in a change in the share of singlehoming and multihoming sellers. When many sellers are active on a platform, the number of multihoming sellers $\mu_s^{NE} = 2n_s^{NE} - 1$ increases, whereas the number of singlehoming sellers $\sigma_s^{NE} = 1 - n_s^{NE}$ decreases. Inserting the seller membership fee (3.3) in the consumer participation yields

$$n_c^{NE} = \frac{r_c + \sigma_s^{NE}\beta_c}{\tau_c}.$$

The mechanism works vice versa on the consumer side. The number of consumers on a platform increases when the number of exclusive sellers σ_s^{NE} increases. The number of singlehoming consumers is given by $\sigma_c^{NE} = 1 - n_c^{NE}$, whereas the number of multihoming consumers is calculated by $\mu_c^{NE} = 2n_c^{NE} - 1$. Finally, the equilibrium platform profit yields

$$\pi^{NE} = \frac{(\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c))^2}{4\tau_c(\tau_c\tau_s - \beta_c\beta_s)}, \tag{3.4}$$

which increases the more the differentiation variables outweigh the cross-group benefits. Since the platform derives revenue from the seller side, it benefits from hosting many sellers and a high membership fee. This is observed when many consumers stay exclusive on one platform.

Equipped with the equilibrium number of sellers and consumers that are active on a platform, as well as with the seller membership fee, we can now derive the market participants' surpluses. In equilibrium, the gross utility of a singlehoming consumer is

$$u_c^{NE} = r_c + \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)}\beta_c$$

and the gross utility of a multihoming consumer is

$$u_c^{M,NE} = 2r_c + \beta_c.$$

Both utilities increase in the standalone value r_c. A singlehoming consumer benefits when more sellers are on the same platform. In contrast, a multihoming consumer meets all sellers, therefore, the cross-group benefit is multiplied by the mass of sellers, which is normalized to one. The gross utility of a singlehoming seller is

$$u_s^{NE} = h_s + \beta_s \frac{r_c + \beta_c}{\tau_c} - \frac{\tau_s(\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c))}{2(\tau_c\tau_s - \beta_c\beta_s)}$$

and the gross utility of a multihoming seller is

$$u_s^{M} = h_s + \beta_s \frac{r_c + \beta_c}{\tau_c}.$$

A seller's utility increases in their net standalone value h_s. Additionally, it increases with the term $\beta_s \frac{r_c+\beta_c}{\tau_c}$. This term indicates that a seller derives a higher utility when consumers' standalone value and cross-group benefit lead to high participation on the consumer side. The gross utility of a multihoming seller is greater than that of a singlehoming seller because singlehoming sellers only derive the cross-group benefits from consumers who are active on the same platform.

To calculate consumer surplus, the utility of each consumer is considered. In the aggregate, the mismatching disutilities for each consumer group are considered. Multihoming consumers are located between x^{AB} and x^{BA}. They enjoy the utility of joining two platforms and realize the mismatching disutility over the entire line segment. Singlehoming consumers obtain the utility of joining one platform and realize the mismatching disutility of joining the closest platform. The aggregated surplus of consumers is

$$CS^{NE} = \int_0^{x_c^{AB}} (u_c^{NE} - \tau_c x_c)\, dx_c + \int_{x_c^{AB}}^{x_c^{BA}} (u_c^{M,NE} - \tau_c)\, dx_c + \int_{x_c^{BA}}^{1} (u_c^{NE} - \tau_c(1 - x_c))\, dx_c.$$

Solving the integrals and inserting the equilibrium values yields

$$CS^{NE} = \frac{1}{\tau_c}\Big(r_c + \Big(1 - \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)}\Big)\beta_c\Big)^2 + \Big(\frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{\tau_c\tau_s - \beta_c\beta_s} - 1\Big)\beta_c.$$

Similarly, the aggregated surplus of sellers amounts to

$$PS^{NE} = \int_0^{x_s^{AB}} (u_s^{A} - \tau_s x_s)\, dx_s + \int_{x_s^{AB}}^{x_s^{BA}} (u_s^{M} - \tau_s)\, dx_s + \int_{x_s^{BA}}^{1} (u_s^{B} - \tau_s(1 - x_s))\, dx_s,$$

solving the integrals and substituting the equilibrium values leads to

$$PS = h_s + \beta_s \frac{r_c + \beta_c}{\tau_c} - \tau_s \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)}\Big(2 - \frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)}\Big).$$

In order to calculate the total welfare, consumer and seller surplus as well as platforms' profits, are taken into account.[2] Inserting the derived equilibrium values in $W^{NE} = CS^{NE} + PS^{NE} + 2\pi^{NE}$ yields

$$\begin{aligned}W^{NE} =& h_s - \beta_c + \frac{\tau_c(h_s+\beta_s) - \beta_s(r_c+\beta_c)}{\tau_c\tau_s - \beta_c\beta_s}\left(\beta_c - \tau_s - \frac{\beta_c(r_c+\beta_c)}{\tau_c}\right) \\ &+ \frac{(r_c+\beta_c)^2 + \beta_s(r_c+\beta_c)}{\tau_c} + \left(\frac{\tau_c(h_s+\beta_s) - \beta_s(r_c+\beta_c)}{2(\tau_c\tau_s - \beta_c\beta_s)}\right)^2\left(\frac{3\tau_c\tau_s + \beta_c^2 - 2\beta_c\beta_s}{\tau_c}\right).\end{aligned}$$

This market outcome only occurs under certain conditions. Partial multihoming only exists if there is an overlap among the indifferent consumers. If some consumers multihome, then all consumers join at least one platform. Additionally, it must be assumed that not all consumers multihome. Formally, these conditions require $0 < x_c^{AB} < x_c^{BA} < 1$. Considering the equilibrium locations and solving them for h_s gives

$$\frac{(2\tau_c\tau_s - \beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c} < h_s < \frac{(2\tau_c\tau_s - \beta_c\beta_s)(r_c+\beta_c-\tau_c) + \tau_c(\tau_c\tau_s - \beta_c\beta_s)}{\tau_c\beta_c}. \tag{3.5}$$

Similarly, partial multihoming exists on the seller side only if $0 < x_s^{AB} < x_s^{BA} < 1$. Reformulating the conditions gives

$$\frac{\tau_c\tau_s + \beta_s r_c - \tau_c\beta_s}{\tau_c} < h_s < \frac{2\tau_c\tau_s - \beta_c\beta_s + \beta_s r_c - \beta_s\tau_c}{\tau_c}. \tag{3.6}$$

Thus, the variable h_s must satisfy the strictest minimum and maximum conditions.

3.5 Platform Competition with Exclusivity Clauses

In this section, platforms enforce exclusivity on one side of the market through exclusivity clauses. It is more feasible for platforms to implement a contract and verify its execution on the seller side than on the consumer side (Doganoglu and Wright, 2009). Therefore, we consider exclusivity clauses on the seller side. Platforms can achieve seller exclusivity by an explicit clause or by imposing an arbitrarily high membership fee on the non-exclusive contract option, which no seller is willing to pay (Wright and Armstrong, 2007). If one of the two platforms requires exclusivity, the exclusivity is set automatically for the entire market (Cong et al., 2022).

[2]The welfare computation follows Lefouili and Pinho (2020).

Consequently, all sellers can only join a single platform.[3]

In the second stage, consumers and sellers decide which platform to join. Since the options available to consumers do not change from Section 3.4, the number of consumers is given by equation (3.1). Sellers evaluate the net utility of joining each platform by considering the gross utilities and differentiation costs. Specifically, the payoff from joining platform A is $u_s^A - \tau_s x_s$, whereas the net utility from joining platform B is $u_s^B - \tau_s(1 - x_s)$. The seller who is indifferent between being active on platform A or B is located at x_s^0. Due to the uniform distribution of sellers, the location of this indifferent seller is equal to the sellers' demand for platform A, i.e., $n_s^A = x_s^0$. Since all sellers are exclusive on one platform, the end of platform A's range implies the beginning of platform B's range. Thus, the demand for platform B is $n_s^B = 1 - x_s^0$. The number of sellers joining platform i is given as

$$n_s^i = \frac{1}{2} + \frac{(n_c^i - n_c^j)\beta_s - (m_s^i - m_s^j)}{2\tau_s}. \tag{3.7}$$

The number of sellers on a platform increases in the number of consumers on the same platform and decreases in the seller membership fee of that platform. Since all sellers are active on one platform, it must hold that $n_s^i = 1 - n_s^j$. Using this fact and solving the equation system (3.1) and (3.7) yields the participation on the consumer side

$$n_c^i = \frac{r_c}{\tau_c} + \frac{\beta_c}{\tau_c}\left(\frac{1}{2} - \frac{\tau_c(m_s^i - m_s^j)}{2(\tau_c\tau_s - \beta_c\beta_s)}\right)$$

and on the seller side

$$n_s^i = \frac{1}{2} - \frac{\tau_c(m_s^i - m_s^j)}{2(\tau_c\tau_s - \beta_c\beta_s)}$$

depending on the seller membership fees.

Now, we move on to the first stage, in which the platforms set their seller membership fees. Platform i maximizes its profit function $\pi_i = (m_s^i - c_s)n_s^i$ with respect to the seller membership fee m_s^i. Due to symmetry, the fee is

$$m_s^E = \tau_s + c_s - \beta_s\frac{\beta_c}{\tau_c}, \tag{3.8}$$

where the superscript E indicates the equilibrium outcomes with exclusivity clauses

[3]The game follows Belleflamme and Peitz (2019). In the game at hand, however, consumers do not pay a membership fee to access the platform.

on the seller side. The fee is similar to the Hotelling formulation, which is defined as $\tau_s + c_s$, but is adjusted downward by the benefit of an additional consumer on the platform. The benefit of an additional consumer consists of two parts. First, each consumer increases a seller's utility by the cross-group benefit β_s. The weight of the adjustment is determined by $\frac{\beta_c}{\tau_c}$, indicating how many consumers join when one additional seller joins the platform (Armstrong, 2006). Thus, the seller membership decreases if the additional seller who joins the platform causes a benefit on the consumer side of the platform.

Using the equilibrium membership fee (3.8) to derive the number of consumers yields

$$n_c^E = \frac{2r_c + \beta_c}{2\tau_c}.$$

More consumers join a platform if they derive a high standalone value r_c and a high cross-group benefit from meeting sellers β_c. Conversely, fewer consumers join the platform as they incur a high mismatching disutility τ_c. The singlehoming and multihoming participation of consumers is $\sigma_c^E = 1 - n_c^E$ and $\mu_c^E = 2n_c^E - 1$. Since platforms choose symmetric membership fees, the market share for sellers is equally divided, implying that $n_s^E = 1/2$. Using the equilibrium fee and the number of sellers on a platform to derive the platform profit yields

$$\pi^E = \frac{\tau_c \tau_s - \beta_c \beta_s}{2\tau_c}. \tag{3.9}$$

Higher differentiation variables increase the platform profit due to the reduced competition. Under such circumstances, platforms charge a higher membership fee on the seller side. Cross-group benefits intensify competition, leading to a lower profit. In equilibrium, the gross utilities of a singlehoming and a multihoming consumer read

$$u_c^E = r_c + \frac{1}{2}\beta_c \quad \text{and} \quad u_c^{M,E} = 2r_c + \beta_c.$$

The gross utilities of multihoming consumers are the same in both settings, i.e., $u_c^{M,NE} = u_c^{M,E} = u_c^M$. The gross utility of a singlehoming seller is

$$u_s^E = h_s + \frac{2r_c + \beta_c}{2\tau_c}\beta_s + \frac{\beta_c}{\tau_c}\beta_s - \tau_s.$$

The utility increases as the net standalone value h_s increases and more consumers join the same platform. Additionally, the utility increases the higher the downward adjustment $\frac{\beta_c}{\tau_c}\beta_s$ in the seller membership fee is. However, the utility decreases the higher the differentiation variable τ_s is because the platform charges sellers a higher fee in that case. The aggregated surplus of all consumers is

$$CS^E = \int_0^{x_c^{AB}} (u_c^E - \tau_c x_c)\ dx_c + \int_{x_c^{AB}}^{x_c^{BA}} (u_c^M - \tau_c)\ dx_c + \int_{x_c^{BA}}^{1} (u_c^E - \tau_c(1 - x_c))\ dx_c.$$

Solving the integrals and inserting the equilibrium values yields

$$CS^E = \frac{(2r_c + \beta_c)^2}{4\tau_c}.$$

The consumer surplus increases the more consumers are active on the platform. The aggregated seller surplus reads

$$PS^E = u_s^E - \int_0^{\frac{1}{2}} \tau_s x_s\ dx_s - \int_{\frac{1}{2}}^{1} \tau_s(1 - x_s)\ dx_s$$

Since all sellers singlehome, the utility of a singlehoming seller is multiplied by the mass of sellers equal to one. Additionally, the total differentiation costs of joining platforms A and B are considered. Solving the integrals and inserting the equilibrium values yields

$$PS^E = h_s + \frac{2r_c + \beta_c}{2\tau_c}\beta_s + \frac{\beta_c}{\tau_c}\beta_s - \frac{5}{4}\tau_s.$$

Summing up the consumer and seller surplus and platforms' profits gives the total welfare that reads

$$W^E = h_s + \frac{(2r_c + \beta_c)^2 + 2\beta_s(2r_c + \beta_c) - \tau_c\tau_s}{4\tau_c}.$$

When platforms generate more value through large standalone values and cross-group benefits, the overall welfare is higher, whereas differentiation leads to a reduction of welfare.

To obtain the derived market outcome, consumers must partially multihome, and all sellers must be willing to be active on one platform. In order to observe partial multihoming on the consumer side $0 < x_c^{AB} < x_c^{BA} < 1$ must hold. Reformulating this condition leads to

$$\frac{1}{2}(\tau_c - \beta_c) < r_c < \frac{1}{2}(2\tau_c - \beta_c).$$

For full seller participation, each sellers net utility from joining a platform must be positive. The indifferent seller located at $x_s = 1/2$ obtains the lowest utility. Hence, the condition $u_s^E - 1/2\tau_s > 0$ must hold. Inserting the equilibrium outcomes yields the condition

$$\frac{3(\tau_c\tau_s - \beta_c\beta_s) - 2r_c\beta_s}{2\tau_c} < h_s. \tag{3.10}$$

The market outcome is observed only if both variables satisfy the conditions.

3.6 Comparison of the Scenarios

To compare the equilibrium outcomes of the two scenarios derived in sections 3.4 and 3.5, the full participation constraint and the partial multihoming conditions must be satisfied. The consumer partial multihoming condition (3.5)[4] and the seller partial multihoming condition (3.6) from the market outcome without exclusivity clauses, as well as the seller full participation condition (3.10) in the outcome with exclusivity clauses, can be summarized in

$$h_s^{\min} < h_s < h_s^{\max}$$

with

$$h_s^{\min} \equiv \max\left\{\frac{3(\tau_c\tau_s - \beta_c\beta_s) - 2r_c\beta_s}{2\tau_c}, \frac{\tau_c\tau_s + \beta_s r_c - \tau_c\beta_s}{\tau_c}\right\} \quad \text{and}$$
$$h_s^{\max} \equiv \min\left\{\frac{(\tau_c\tau_s - \beta_c\beta_s)(r_c + \beta_c) + \tau_c\tau_s(r_c + \beta_c - \tau_c)}{\tau_c\beta_c}, \frac{2\tau_c\tau_s - \beta_c\beta_s + \beta_s r_c - \beta_s\tau_c}{\tau_c}\right\}.$$

The net standalone value on the seller side must satisfy the strictest minimum and maximum conditions. Additionally, to ensure consumer partial multihoming in the market outcome with exclusivity clauses, the standalone value on the consumer side must satisfy

$$\frac{1}{2}(\tau_c - \beta_c) < r_c < \frac{1}{2}(2\tau_c - \beta_c). \tag{3.11}$$

We are now ready to compare the market outcomes in the case where the variables h_s and r_c are lying within the defined ranges.

[4]The minimum condition of equation (3.5) is satisfied given the other conditions. This statement, referred to as Statement 3.1, is specified in the Appendix A3.1.

3.6.1 Platforms' Perspective

Platforms have the power to define contract terms because they are often the only channel for sellers to interact with consumers. They propose exclusive contracts if the derived profits are larger compared to the profits derived in a situation with multihoming sellers. The platforms' profit functions depend on the seller membership fee and the number of sellers joining a platform.

First, we consider the effect of the seller membership fee. Sellers pay a higher fee when they are forced to singlehome if $m_s^E - m_s^{NE} > 0$ holds. Inserting the equilibrium membership fees (3.3) and (3.8) in the inequality gives

$$\tau_s + c_s - \beta_s \frac{\beta_c}{\tau_c} - \left(\frac{\tau_c(h_s + \beta_s) - \beta_s(r_c + \beta_c)}{2\tau_c} + c_s \right) > 0.$$

A lower differentiation cost τ_s and higher cross-group benefits $\beta_c\beta_s$ intensify price competition in the exclusive setting, leading to a decrease in m_s^E. A change of τ_s does not affect m_s^{NE}. Also, an increase in the cross-group benefits $\beta_c\beta_s$ does not lower m_s^{NE} to the same extent as m_s^E. Therefore, intense price competition through lower τ_s or higher $\beta_c\beta_s$ lowers the membership fee in the exclusive setting more than in the non-exclusive setting. The net standalone value on the seller side h_s has no effect on the membership fee in the exclusive setting but increases the fee in the non-exclusive setting. Solving the inequality for h_s yields

$$h_s^{m_s} \equiv \frac{2\tau_c\tau_s - \beta_c\beta_s + \beta_s(r_c - \tau_c)}{\tau_c}.$$

The threshold $h_s^{m_s}$, where sellers pay the same in both market environments, is identical to one of the two $h_s^{\max}$ conditions. Below $h_s^{m_s}$ and within the feasible area, sellers pay more when exclusivity is enforced. Therefore, when sellers partially multihome, the fee is lower than that in a market environment with exclusivity clauses. The underlying effect is the price sensitivity effect, which was first observed by Chen and H. Riordan (2008) and applied to the users' homing analysis by Belleflamme and Peitz (2019). Platforms are more effective in attracting sellers by a fee cut when sellers can multihome. Therefore, they lower the fee to a greater extent in the environment without exclusivity clauses.

Second, the effect of seller participation is taken into account. Multihoming occurs only if some sellers join both platforms. The overlap yields higher seller participation in an environment without exclusivity clauses. The indifference curve resulting from the inequality $n_s^E - n_s^{NE} > 0$ at equality is given by

$$h_s^{n_s} \equiv \frac{\tau_c \tau_s + \beta_s r_c - \tau_c \beta_s}{\tau_c}$$

and equals one of the two $h_s^{\min}$ conditions. Thus, if exclusivity is enforced, platforms experience a lower seller demand. Hence, not offering exclusive contracts is attractive to platforms if the greater participation on the seller side offsets the lower membership fee.

The price effect suggests that platforms make higher profits with exclusivity clauses, whereas the effect on the seller participation implies lower profits with exclusivity clauses. Platforms consider both effects and enforce exclusivity if $\pi^E - \pi^{NE} > 0$. The profits (3.4) and (3.9) are inserted into $\pi^E - \pi^{NE} > 0$ and the inequality is solved for h_s. The derived threshold h_s^π denotes when platforms are indifferent between enforcing exclusivity clauses or not. The threshold value is

$$h_s^\pi \equiv \frac{\beta_s(r_c + \beta_c - \tau_c) + \sqrt{2}(\tau_c \tau_s - \beta_c \beta_s)}{\tau_c}.$$

For values of h_s below h_s^π, platforms derive higher profits if they enforce exclusivity on the seller side. In this area, the higher fee outweighs the lower seller participation. In the area above h_s^π, platforms prefer to allow multihoming because the large seller participation results even with a lower fee in higher profits. The results are summarized in Lemma 3.1.

Lemma 3.1. *For values $h_s \in (h_s^{\min}, h_s^{\max})$, $m_s^E > m_s^{NE}$ and $n_s^E < n_s^{NE}$ hold. For values of h_s below h_s^π, $\pi^E > \pi^{NE}$ holds. For values of h_s above h_s^π, $\pi^E < \pi^{NE}$ holds.*

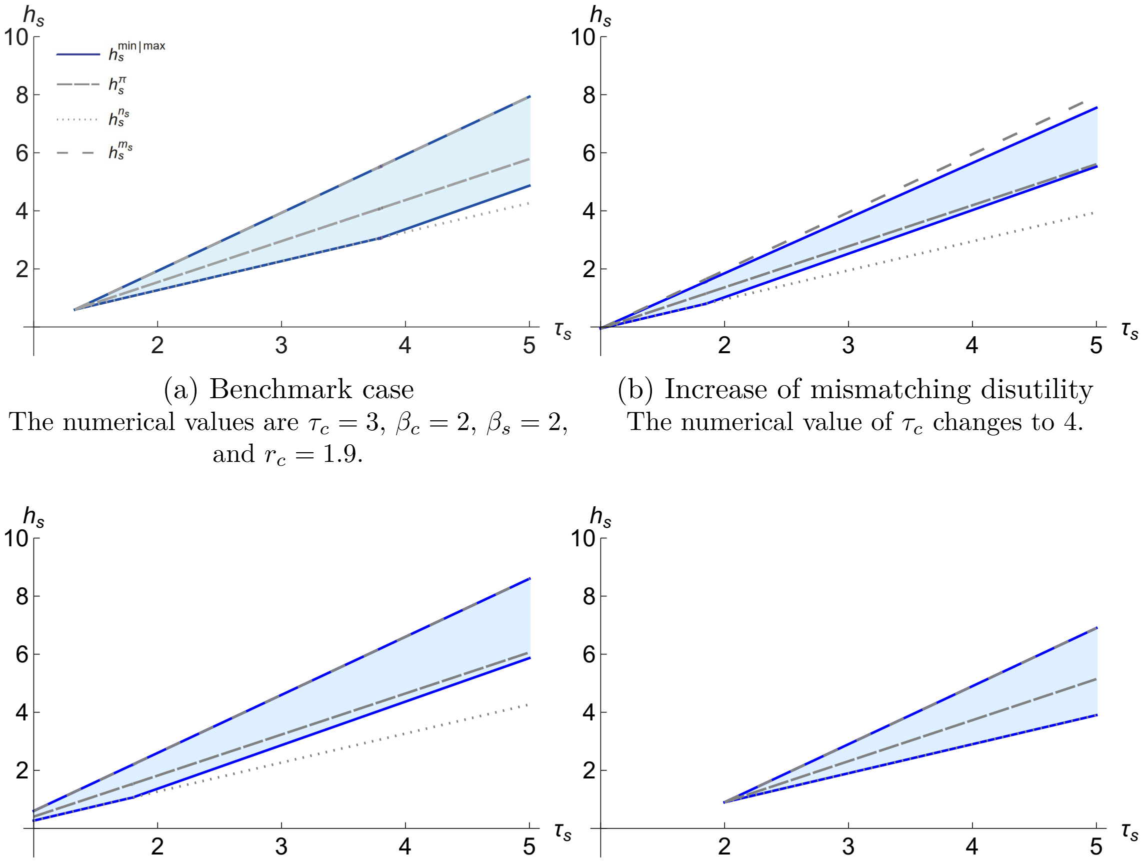
Proof. See Appendix A3.1 □

To illustrate the effects of exclusivity clauses on platforms' profits, we introduce a numerical example. Figure 3.1 shows how the indifference curves change when the net standalone value h_s and differentiation cost τ_s develop. As noted in Section 3.3, an adequate level of differentiation is required. Therefore, only parameter constellations satisfying

$$\tau_s > \frac{\beta_c \beta_s}{\tau_c} \tag{3.12}$$

are considered. The two market outcomes can be compared if h_s is in the blue, shaded area enclosed by $h_s^{\min}$ and $h_s^{\max}$. The dashed line presents the platforms' profits indifference curve h_s^π. The widely dashed line indicates the threshold $h_s^{m_s}$ where sellers pay the same fee in both market environments. The dotted line indicates the indifference curve $h_s^{n_s}$ where the same number of sellers is active in both market environments. The indifference curves vary with the exogenous parameter values. To capture the effects of the variables, four numerical variations are presented in Figure 3.1.

Figure 3.1: Indifference Curve of Platforms' Profits



(a) Benchmark case
The numerical values are $\tau_c = 3$, $\beta_c = 2$, $\beta_s = 2$, and $r_c = 1.9$.

(b) Increase of mismatching disutility
The numerical value of τ_c changes to 4.

(c) Decrease of consumer cross-group benefit
The numerical value of β_c changes to 1.

(d) Increase of seller cross-group benefit
The numerical value of β_s changes to 3.

Figure 3.1a depicts the benchmark outcome. The blue shaded area is divided into two parts by h_s^π. Above h_s^π platforms prefer that a fraction of sellers multihome. In this area, the m_s^{NE} is lower than m_s^E, but the difference between the fees is minor due to the higher h_s that causes a higher m_s^{NE}. Although the seller fee is lower, it is beneficial for the platforms to allow sellers to multihome as the larger seller demand offsets the lower fee. As h_s decreases, the fee m_s^{NE} also does. Below h_s^π, platforms offer exclusive agreements. In this area, the additional sellers cannot offset the lower fee.

Next, through a change in the numerical values of the mismatching disutility τ_c and the cross-group benefit β_c, joining a platform becomes less attractive to consumers. Figure 3.1b depicts the effect of an increase in the mismatching disutility on the consumer side. As τ_c increases, the feasible area shrinks. Joining a platform becomes less attractive to sellers in the exclusive setting as they meet fewer consumers and pay a higher fee. Hence, the $h_s^{\min}$ condition, which ensures the participation of sellers, shifts upward. The area where platforms prefer non-exclusive sellers becomes proportionally larger. Thus, when joining a platform is rather unattractive for consumers, the platform benefits from allowing sellers to multihome. Consequently, many sellers will join a second platform as they meet exclusive consumers on the additional platform. The same mechanism occurs with a decreasing cross-group benefit on the consumer side, as shown in Figure 3.1c.

Figure 3.1d illustrates how the market changes as the cross-group benefit β_s on the seller side increases. The increase in β_s leads to an upward shift of the feasible area as the condition stated in equation (3.12) gets stricter.

3.6.2 Welfare Analysis

To examine the effects of exclusivity clauses on platform markets, the effects on platforms, consumers, and sellers are considered. The surpluses derived in sections 3.4 and 3.5 allow us to investigate the consumers' and sellers' perspectives.

First, the consumer side is examined. We take the gross utility of two groups into account. Consumers who singlehome in both environments experience a change in gross utilities, i.e., $u_c^E - u_c^{NE} = (1/2 - n_s^{NE})\beta_c$. The change in utility is caused by the varying number of sellers. The previous section proves that the number of sellers is larger with multihoming on the seller side, implying that $1/2 < n_s^{NE}$. Thus, the so-called participation effect prompts that singlehoming consumers have a disadvantage as they meet fewer sellers on a platform if platforms enforce exclusivity on the seller side. Consumers who multihome in both environments experience no change in gross utilities. To examine the effects' weight on the aggregated consumer surplus, we consider the changes in consumers' composition. Consumer participation is higher when platforms impose exclusivity on the seller side if $n_c^E - n_c^{NE} > 0$. Inserting the equilibrium values and solving the inequality for h_s gives

$$h_s^{n_c} \equiv \frac{\tau_c \tau_s + \beta_s r_c - \beta_s \tau_c}{\tau_c},$$

which equals one of the two $h_s^{\min}$ conditions. Therefore, in the feasible area, more consumers are active on a platform if sellers sign exclusivity clauses. This trend can already be seen from equation (3.1). A platform attracts more consumers when it hosts many exclusive sellers. In the extreme case, when all sellers are exclusive on one platform, the number of consumers is the highest. The more consumers are active on a platform, the larger the proportion of multihoming consumers, indicating that $\mu_c^E > \mu_c^{NE}$. Respectively, the proportion of singlehoming consumers shrinks, implying that $\sigma_c^E < \sigma_c^{NE}$. The aggregated consumer surplus accounts for all consumers' gross utilities as well as their mismatching disutilities. The surplus of consumers is greater with exclusivity clauses on the seller side if $CS^E - CS^{NE} > 0$. We compare the surpluses before inserting the equilibrium equations:

$$\underbrace{2(\sigma_c^E u_c^E - \sigma_c^{NE} u_c^{NE})}_{\text{singlehoming consumers' utilities}} + \underbrace{u_c^M(\mu_c^E - \mu_c^{NE})}_{\text{multihoming consumers' utilities}} - \underbrace{\tau_c(n_c^E - n_c^{NE})(n_c^E + n_c^{NE})}_{\text{consumers' mismatching disutilities}} > 0.$$

Given the lower utility of singlehoming consumers and the lower number of singlehoming consumers, the aggregated utility of singlehoming consumers is lower with seller exclusivity. More consumers will multihome, therefore, the aggregated utility of multihoming consumers is higher with seller exclusivity. However, due to the shift toward multihoming, the mismatching disutilities increase in the aggregate. Inserting the equilibrium equations in the inequality and solving for h_s gives the indifference curve

$$h_s^{CS} \equiv \frac{(2\tau_c\tau_s - \beta_c\beta_s)(r_c + \beta_c - \tau_c)}{\tau_c\beta_c} + \frac{|2r_c + \beta_c - 2\tau_c|(\tau_c\tau_s - \beta_c\beta_s)}{\tau_c\beta_c}.$$

For values of h_s above the indifference curve h_s^{CS}, consumers prefer a market environment without exclusivity clauses. The indifference curve equals one of the two $h_s^{\min}$ conditions. Thus, in the feasible area, consumers suffer from seller exclusivity because many consumers experience a larger mismatching disutility. The finding is stated in Lemma 3.2.

Lemma 3.2. *For values $h_s \in (h_s^{\min}, h_s^{\max})$, $CS^E < CS^{NE}$ holds.*

Proof. See Appendix A3.1 □

Second, the seller side is taken into account. A group of sellers singlehome in both settings. Their gross utility differs depending on the participation and price effect, i.e., $u_s^E - u_s^{NE} = (n_c^E - n_c^{NE})\beta_s - (m_s^E - m_s^{NE})$. As shown above, the number of consumers is higher if sellers are exclusive on one platform, i.e., $n_c^E > n_c^{NE}$. It was also shown that sellers pay more with exclusivity clauses, i.e., $m_s^E > m_s^{NE}$.

Consequently, sellers who singlehome in both environments benefit because they meet more consumers but suffer because they pay a higher fee with exclusivity clauses. Another group of sellers switches to multihoming when they are permitted to do so. Their obtained gross utility changes as they derive the additional standalone value and experience a difference in consumers met and the fee paid, i.e., $u_s^E - u_s^M = -r_s + (n_c^E - 1)\beta_s - (m_s^E - 2m_s^{NE})$. These sellers meet more consumers because the number of consumers on one platform in the exclusive setting is lower than the total mass of consumers they meet when multihoming, i.e., $n_c^E < 1$. The participation effect makes them a beneficiary of an environment without exclusivity clauses. However, the multihoming sellers pay the membership fee twice. Additionally, as some sellers multihome, sellers incur more differentiation costs. The surplus of sellers in the aggregate is larger if they are required to be exclusive on one platform if $PS^E - PS^{NE} > 0$:

$$\underbrace{u_s^E - 2\sigma_s^{NE}u_s^{NE}}_{\text{singlehoming sellers' utilities}} - \underbrace{u_s^M\mu_s^{NE}}_{\text{multihoming sellers' utilities}} - \underbrace{\tau_s\left(\frac{1}{4} - (n_s^{NE})^2\right)}_{\text{sellers' differentiation costs}} > 0$$

The effect of exclusivity clauses on the seller side is ambiguous. Sellers suffer from higher fees in an environment with exclusive contracts. However, they benefit as more consumers multihome and they incur fewer differentiation costs. Inserting the equilibrium equations in the inequality and solving for h_s yields

$$h_s^{PS} \equiv \frac{2\tau_c\tau_s - \beta_c\beta_s + \beta_s r_c - \beta_s\tau_c}{\tau_c} - \frac{\sqrt{\tau_c\tau_s(2\beta_c\beta_s - \tau_c\tau_s)}(\tau_c\tau_s - \beta_c\beta_s)}{\tau_c^2\tau_s}.$$

The first part of the function is equal to one of the $h_s^{\max}$ conditions. For values below the maximum condition and above h_s^{PS}, sellers benefit from exclusivity clauses. This area becomes greater if the second part is large. The area exists only for $2\beta_c\beta_s > \tau_c\tau_s$. In the exclusive setting, the price competition is intensified for large cross-group benefits and low differentiation variables. Under intense price competition, the fee is still larger in the exclusive outcome ($m_s^E > m_s^{NE}$). However, sellers in the aggregate can benefit because in the exclusive setting all sellers pay for the membership only once. Lemma 3.3 summarizes the finding.

Lemma 3.3. *For values $h_s \in (h_s^{\min}, h_s^{\max})$ and above h_s^{PS}, $PS^E > PS^{NE}$ holds. For values of h_s below h_s^{PS}, $PS^E < PS^{NE}$ holds.*

Proof. See Appendix A3.1 □

The lemmas are combined to obtain the overall picture. According to Lemma 3.2, consumers prefer an outcome without seller exclusivity. While platforms benefit for low values of h_s from exclusivity clauses as stated in Lemma 3.1. The effect on the platform's decision determined by Lemma 3.1 on the consumer surplus is stated in Proposition 3.1.

Proposition 3.1. *Whenever platforms enforce exclusivity on the seller side, consumers suffer from the platforms' decision.*

Platforms' profits and the seller surplus can be larger in the non-exclusive outcome. Platforms allow multihoming when the additional seller participation offsets the lower fee. This is observed for high values of h_s as defined by Lemma 3.1. The seller surplus is larger in the non-exclusive outcome for all admissible values of h_s if $2\beta_c\beta_s < \tau_c\tau_s$. In the feasible area, the consumer surplus is strictly larger in the non-exclusive setting. Proposition 3.2 combines the findings.

Proposition 3.2. *It is possible that consumers, sellers, and platforms benefit from an outcome without exclusivity clauses.*

Platforms and sellers benefit in some circumstances from exclusivity clauses. The indifference curve of the seller surplus intersects with the $h_s^{\max}$ condition if $2\beta_c\beta_s = \tau_c\tau_s$. For moderate cross-group benefits, the area where sellers benefit from exclusivity is small and close to the $h_s^{\max}$ condition. Therefore, only for large values of h_s and low values of τ_s, sellers benefit from exclusivity clauses. If h_s is rather high, platforms do not offer exclusivity clauses. These results are summarized in Proposition 3.3.

Proposition 3.3. *If platforms enforce exclusivity and cross-group benefits are moderate, sellers suffer from platforms' decisions.*

However, if the cross-group benefits are strong, platforms and sellers may benefit from exclusivity on the seller side. This area exists for $h_s^{PS} < h_s^{\pi}$ and is defined in Lemma 3.4.

Lemma 3.4. *For some values of* $h_s \in (h_s^{\min}, h_s^{\max})$ *the seller surplus and platforms' profits are higher with exclusivity clauses if* $(2-\sqrt{2})\tau_c\tau_s < \sqrt{\tau_c\tau_s(2\beta_c\beta_s - \tau_c\tau_s)}$.

Proof. See Appendix A3.1 □

This lemma implies the following proposition.

Proposition 3.4. *If cross-group benefits are strong, an area where sellers and platforms benefit from seller exclusivity clauses exists.*

Next, the surpluses of the different parties are summed up to consider the total welfare effects. The total welfare is higher if platforms impose exclusivity for sellers if $W^E - W^{NE} > 0$:

$$CS^E - CS^{NE} + PS^E - PS^{NE} + 2(\pi^E - \pi^{NE}) > 0$$

In the admissible range, consumers suffer from exclusivity clauses. Thus, when exclusivity clauses are welfare-enhancing, it must be driven by the seller surplus and platforms' profits. The indifference curve is

$$h_s^W \equiv \frac{\tau_c\tau_s + \beta_s r_c - \beta_s\tau_c}{\tau_c} + \frac{(\tau_c\tau_s - \beta_c\beta_s)\left(\beta_c(2r_c - (2\tau_c - \beta_c)) + 2\beta_c\beta_s - \tau_c\tau_s\right.}{\tau_c(2(\tau_c\tau_s - \beta_c\beta_s) + \beta_c^2 + \tau_c\tau_s)} + \frac{\left.|\beta_c\left(2r_c - (2\tau_c - \beta_c)\right) + 2\beta_c\beta_s - \tau_c\tau_s|\right)}{\tau_c(2(\tau_c\tau_s - \beta_c\beta_s) + \beta_c^2 + \tau_c\tau_s)}.$$

The indifference curve equals one of the $h_s^{\min}$ conditions if $\beta_c(2r_c - (2\tau_c - \beta_c)) + 2\beta_c\beta_s - \tau_c\tau_s < 0$. For variable constellations where $\beta_c(2r_c - (2\tau_c - \beta_c)) + 2\beta_c\beta_s - \tau_c\tau_s > 0$ holds, there exists an area where the total welfare is higher with exclusivity contracts. Given the specifications of r_c in equation (3.11), the term in parentheses is negative. Exclusivity clauses are welfare-enhancing if the second part $2\beta_c\beta_s - \tau_c\tau_s$ is sufficiently large. The findings are summarized in Lemma 3.5.

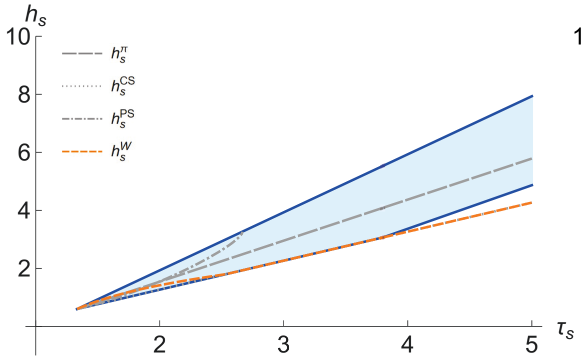
Lemma 3.5. *For values $h_s \in (h_s^{\min}, h_s^{\max})$ and above h_s^W, $W^E < W^{NE}$ holds. For values of h_s below h_s^W, $W^E > W^{NE}$ holds.*

Proof. See Appendix A3.1 □

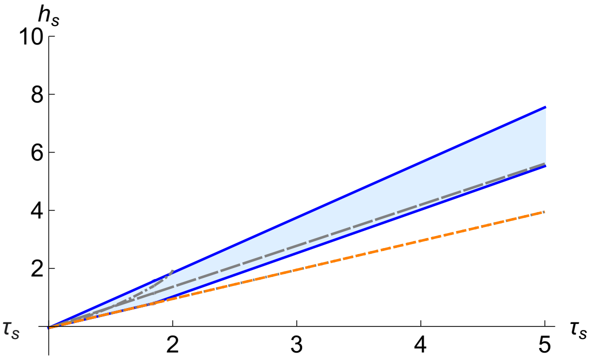
The numerical example from above facilitates the interpretation. The setting of Figure 3.2 is the same as in Figure 3.1. Again, the dashed line represents the platforms' profits indifference curve h_s^π. The dashed, dotted line indicates the indifference curve of the seller surplus h_s^{PS} and the dotted line shows the indifference curve of the consumer surplus h_s^{CS}. The orange dashed line displays the indifference curve of the total welfare h_s^W.

Figure 3.2a shows the indifference curves in the benchmark numerical example. The indifference curve of the consumer surplus h_s^{CS} is hidden behind $h_s^{\min}$ or h_s^W. Below the h_s^π indifference line, platforms enforce exclusivity on the seller side. As stated in Proposition 3.2, consumers suffer from the platforms' decisions. Above the threshold value h_s^{PS}, the seller surplus is larger if they sign exclusivity clauses. The considered area is located above the h_s^π indifference line. In this area, the platforms will not offer exclusivity clauses as it is not profitable for them. Hence, sellers suffer

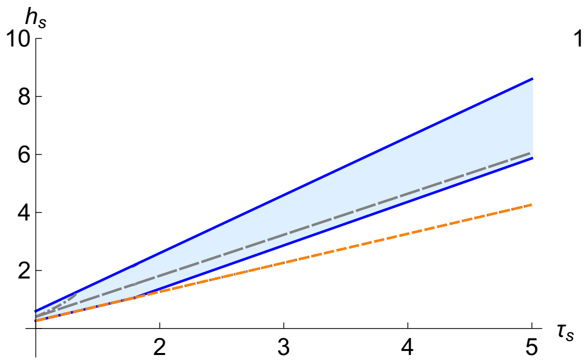
Figure 3.2: Indifference Curves of Surpluses



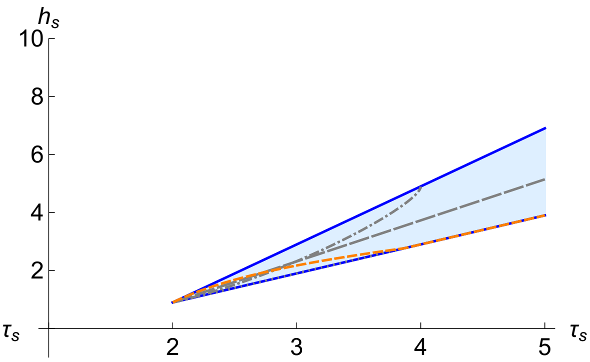
(a) Benchmark case
The numerical values are $\tau_c = 3$, $\beta_c = 2$, $\beta_s = 2$, and $r_c = 1.9$.



(b) Increase of mismatching disutility
The numerical value of τ_c changes to 4.



(c) Decrease of consumer cross-group benefit
The numerical value of β_c changes to 1.



(d) Increase of seller cross-group benefit
The numerical value of β_s changes to 3.

from the platforms' decisions as stated in Proposition 3.3. For values of h_s below h_s^{PS} and for values of h_s in combination with a sufficiently large differentiation cost variable $2.7 < \tau_s$ (satisfying $2\beta_s\beta_s < \tau_c\tau_s$), platforms, consumers, and sellers prefer a non-exclusive outcome as stated in Proposition 3.2.

Figure 3.2b shows the market outcome when the consumer mismatching disutility τ_c increases. The area where sellers prefer exclusivity clauses shrinks. A higher τ_c makes multihoming more attractive to sellers as fewer consumers join a platform. By joining two platforms, sellers can counteract the lower participation on the consumer side. A decrease in the cross-group benefit of consumers β_c, as shown in Figure 3.2c, has a similar effect. The opposite happens as the cross-group benefit on the seller side β_s increases as in Figure 3.2d. The area where sellers benefit from exclusivity clauses is larger in Figure 3.2d compared to Figure 3.2a because of the increase in the cross-group effect β_s, and occurs only for low values of τ_s. As discussed before, for high β_s and low τ_s, the price competition in the exclusive outcome is fierce.

Therefore, the seller fee in the exclusive setting is lower, and each seller pays the fee only once. Due to this combination, the sellers find the exclusive setting beneficial.

The total welfare is in a wide range of cases larger in an environment without exclusivity clauses. However, Figures 3.2a and 3.2d show an area where exclusivity agreements can be welfare-enhancing. These areas occur below the indifference curve h_s^W. Actually, this area overlaps with the area where platforms issue exclusivity clauses. Therefore, in this parameter constellation, exclusivity clauses are welcomed from a welfare perspective. The total welfare is higher with exclusivity clauses if the positive effects on the seller surplus and platforms' profits dominate the negative effects on the consumer surplus. The area where exclusivity clauses are welfare-enhancing is larger if sellers' surplus with exclusivity is also larger. As stated in Proposition 3.4 and as can be seen in Figure 3.2d, an area where sellers and platforms benefit from exclusivity clauses exists. It occurs below the h_s^π line and above the h_s^{PS} line. In this parameter constellation, the total welfare is higher with exclusivity clauses. Therefore, exclusivity clauses can be welfare-enhancing if price competition in the exclusive outcome is intense.

3.7 Summary and Conclusion

The chapter compares a two-sided platform duopoly market with partial multihoming on the consumer and seller side to a setting with partially multihoming consumers and singlehoming sellers. The singlehoming behavior on the seller side can be enforced by the platforms that offer exclusivity clauses to sellers. The conditions under which seller exclusivity clauses benefit or harm platforms, consumers, and sellers are derived.

In the version without exclusivity clauses on the seller side, the attractiveness of a platform for sellers depends on the number of exclusive consumers. Consequently, the number of sellers on a platform and the fee paid increase as more consumers stay exclusive on one platform. When platforms enforce seller exclusivity, price competition is intensive if platforms are not much differentiated from the sellers' perspective and meeting the opposing market side is particularly valuable. In this case, consumer participation increases as they obtain more utility from joining both platforms and meeting exclusive sellers on each platform. Fewer consumers join the platform if platforms are very differentiated from the consumers' perspective. The number of sellers on each platform is lower if the platform requires exclusivity on the seller side compared to the outcome without exclusivity. We show that platforms set a lower membership fee if sellers can multihome. They only allow sellers to multihome if the additional sellers joining a platform offset the lower fee. If all sellers are exclusive on a platform, more consumers join two platforms. Thus, in the aggregate, consumers have to incur more costs to be active on the platforms. Therefore, consumers prefer a setting without seller exclusivity. If joining a platform becomes less attractive to consumers, sellers particularly benefit if they can multihome. By joining both platforms, sellers can counteract the lower participation on the consumer side. If price competition is very intensive in the exclusive outcome, sellers might also prefer exclusive agreements. They still pay higher fees, but the difference in fees is small, and they incur less differentiation costs for joining both platforms. The total welfare is predominantly higher without exclusivity clauses. Only in an intense price competition in the exclusive setting it is not optimal to ban exclusivity clauses.

Our results confirm that the regulators should critically review exclusivity clauses. A ban on such clauses would result in a lower seller membership fee and a higher surplus for consumers. If platforms offer exclusivity clauses, it is mostly to the disadvantage of sellers. Therefore, sellers would predominantly benefit from a ban. Platforms, however, could make lower profits.

A3.1 Proofs of Statements and Lemmas

Proof of Statement 3.1.
The minimum condition of equation (3.5) is below the minimum condition $h_s^{\min} \equiv \frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$ if

$$\frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c} > \frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}$$
$$r_c < \frac{1}{2}(2\tau_c-\beta_c).$$

Given equation (3.11) the inequality holds. □

Proof of Lemma 3.1.
The platform profit is higher with exclusivity clauses if $\pi^E - \pi^{NE} > 0$. Inserting the platform profits (3.4) and (3.9) in the inequality yields

$$\frac{\tau_c\tau_s-\beta_c\beta_s}{2\tau_c} - \frac{(\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c))^2}{4\tau_c(\tau_c\tau_s-\beta_c\beta_s)} > 0$$
$$2(\tau_c\tau_s-\beta_c\beta_s)^2-\beta_s^2(r_c+\beta_c-\tau_c)^2+2h_s\beta_s\tau_c(r_c+\beta_c-\tau_c)-\tau_c^2h_s^2 > 0.$$

Solving the inequality for h_s gives two indifference curves.

$$h^{\pi}_{s|1,2} \equiv \frac{\beta_s(r_c+\beta_c-\tau_c)\pm\sqrt{2}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c}$$

The second solution $h^{\pi}_{s|2} \equiv \frac{\beta_s(r_c+\beta_c-\tau_c)-\sqrt{2}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c}$ is below $h_s^{\min} \equiv \frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$ because

$$\frac{\beta_s(r_c+\beta_c-\tau_c)-\sqrt{2}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c} < \frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$$
$$-\sqrt{2} < 1.$$

As $h^{\pi}_{s|2}$ is strictly below one of the $h_s^{\min}$ conditions it is outside the feasible area and only the first solution of $h^{\pi}_{s|1,2}$ is considered in Lemma 3.1. □

Proof of Lemma 3.2.
The consumer surplus is higher with exclusivity clauses if $CS^E - CS^{NE} > 0$. Inserting the equilibrium consumer surpluses of the two scenarios in the inequality

yields

$$\beta_c\Big(\frac{\beta_c+4r_c}{4\tau_c}-\frac{2r_c}{\tau_c}\Big(\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{2(\tau_c\tau_s-\beta_c\beta_s)}\Big)-\frac{\beta_c}{\tau_c}\Big(\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{2(\tau_c\tau_s-\beta_c\beta_s)}\Big)^2\Big)$$
$$+(2r_c+\beta_c-\tau_c)\Big(\frac{r_c}{\tau_c}-\frac{\tau_s(r_c+\beta_c)-\beta_c(h_s+\beta_s)}{\tau_c\tau_s-\beta_c\beta_s}\Big)>0.$$

After rearranging the inequality reads

$$(\tau_c\tau_s-\beta_c\beta_s)^2\beta_c-4(\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)(\beta_s r_c+\tau_c\tau_s-\tau_c\beta_s)-\beta_c\beta_s^2(r_c+\beta_c-\tau_c)^2$$
$$+2h_s\tau_c(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)-h_s^2\beta_c\tau_c^2>0.$$

Solving the inequality for h_s gives two indifference curves.

$$h_{s|1,2}^{CS}\equiv\frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}\pm\frac{|2r_c+\beta_c-2\tau_c|(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c\beta_c}$$

The second solution $h_{s|2}^{CS}\equiv\frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}-\frac{|2r_c+\beta_c-2\tau_c|(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c\beta_c}$ is below $h_s^{\min}\equiv\frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$ if

$$\frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}-\frac{|2r_c+\beta_c-2\tau_c|(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c\beta_c}<\frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$$
$$(2r_c-(2\tau_c-\beta_c))-|2r_c-(2\tau_c-\beta_c)|<0.$$

Given equation (3.11) the expression in parentheses is negative. Therefore, given the minus sign in front of the absolute value, the inequality holds. As $h_{s|2}^{CS}$ is strictly below one of the $h_s^{\min}$ conditions it is outside the feasible area and only the first solution of $h_{s|1,2}^{CS}$ is considered in Lemma 3.2.

The first solution $h_{s|2}^{CS}\equiv\frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}+\frac{|2r_c+\beta_c-2\tau_c|(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c\beta_c}$ is equal to $h_s^{\min}\equiv\frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$ if

$$\frac{(2\tau_c\tau_s-\beta_c\beta_s)(r_c+\beta_c-\tau_c)}{\tau_c\beta_c}-\frac{|2r_c+\beta_c+2\tau_c|(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c\beta_c}=\frac{\tau_c\tau_s+\beta_s r_c-\tau_c\beta_s}{\tau_c}$$
$$(2r_c-(2\tau_c-\beta_c))+|2r_c-(2\tau_c-\beta_c)|=0.$$

Given equation (3.11) the expression in parentheses is negative. Therefore, given the plus sign in front of the absolute value, the whole expression equals zero. □

Proof of Lemma 3.3.
The seller surplus is higher with exclusivity clauses if $PS^E-PS^{NE}>0$. Inserting

the equilibrium seller surpluses of the two scenarios in the inequality yields

$$\frac{\beta_c\beta_s}{2\tau_c} - \frac{5}{4}\tau_s + \tau_s\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{2(\tau_c\tau_s-\beta_c\beta_s)}\left(2-\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{2(\tau_c\tau_s-\beta_c\beta_s)}\right) > 0$$

After rearranging the inequality reads

$$(\tau_c\tau_s-\beta_c\beta_s)^2(2\beta_c\beta_s-5\tau_c\tau_s)+4\tau_c\tau_s\beta_s(\tau_c\tau_s-\beta_c\beta_s)(\tau_c-r_c-\beta_c)-\tau_s\tau_c\beta_s^2(\tau_c-r_c+\beta_c)^2$$
$$+2h_s\tau_s\tau_c^2(2(\tau_c\tau_s-\beta_c\beta_s)+\beta_s(r_c+\beta_c-\tau_c))-\tau_s\tau_c^3h_s^2 > 0.$$

Solving the inequality for h_s gives two indifference curves.

$$h_{s|1,2}^{PS} \equiv \frac{2\tau_c\tau_s-\beta_c\beta_s+\beta_s r_c-\beta_s\tau_c}{\tau_c} \pm \frac{\sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c^2\tau_s}$$

The first solution $h_{s|1}^{PS} \equiv \frac{2\tau_c\tau_s-\beta_c\beta_s+\beta_s r_c-\beta_s\tau_c}{\tau_c} + \frac{\sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c^2\tau_s}$ is above $h_s^{\max} \equiv \frac{2\tau_c\tau_s-\beta_c\beta_s+\beta_s r_c-\beta_s\tau_c}{\tau_c}$ if

$$\frac{\sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c^2\tau_s} > 0$$
$$\sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)} > 0.$$

The inequality holds for any existing solution. As $h_{s|2}^{PS}$ is strictly above one of the $h_s^{\max}$ conditions it is outside the feasible area and only the second solution of $h_{s|1,2}^{PS}$ is considered in Lemma 3.3. □

Proof of Lemma 3.4.
An area where platforms and sellers benefit from seller exclusivity clauses exists if h_s^{PS} is below h_s^{π}. Inserting the respective indifference curves in $h_s^{PS} < h_s^{\pi}$ yields

$$\frac{2\tau_c\tau_s-\beta_c\beta_s+\beta_s r_c-\beta_s\tau_c}{\tau_c} - \frac{\sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c^2\tau_s} < \frac{\beta_s(r_c+\beta_c-\tau_c)}{\tau_c}$$
$$+\frac{\sqrt{2}(\tau_c\tau_s-\beta_c\beta_s)}{\tau_c}$$

After rearranging the inequality reads

$$(2-\sqrt{2})\tau_c\tau_s < \sqrt{\tau_c\tau_s(2\beta_c\beta_s-\tau_c\tau_s)}.$$

This condition is stated in Lemma 3.4. □

Proof of Lemma 3.5.
The total welfare is higher with exclusivity clauses if $W^E - W^{NE} > 0$. Inserting the equilibrium total welfare of the two scenarios in the inequality yields

$$\frac{(2r_c+\beta_c)^2+2\beta_s(2r_c+\beta_c)-\tau_c\tau_s}{4\tau_c}+\beta_c-\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{\tau_c\tau_s-\beta_c\beta_s}\left(\beta_c-\tau_s-\frac{\beta_c(r_c+\beta_c)}{\tau_c}\right)$$
$$-\frac{(r_c+\beta_c)^2+\beta_s(r_c+\beta_c)}{\tau_c}-\left(\frac{\tau_c(h_s+\beta_s)-\beta_s(r_c+\beta_c)}{2(\tau_c\tau_s-\beta_c\beta_s)}\right)^2\left(\frac{3\tau_c\tau_s+\beta_c^2-2\beta_c\beta_s}{\tau_c}\right)>0$$

After rearranging the inequality reads

$$\begin{aligned}&(\tau_c\tau_s-\beta_c\beta_s)^2(\beta_c(4\tau_c-4r_c-3\beta_c-2\beta_s)-\tau_c\tau_s)-4\beta_s\tau_c\tau_s(r_c+\beta_c-\tau_c)(\tau_c\tau_s-\beta_c\beta_s)\\&-\beta_s(r_c+\beta_c-\tau_c)^2(4\beta_c(\tau_c\tau_s-\beta_c\beta_s)+\beta_s(3\tau_c\tau_s+\beta_c^2-2\beta_c\beta_s))\\&+2h_s\tau_c((\tau_c\tau_s+\beta_sr_c-\beta_s\tau_c)(3\tau_c\tau_s+\beta_c^2-2\beta_c\beta_s)\\&+(\tau_c\tau_s-\beta_c\beta_s)(\beta_c(2r_c-2\tau_c+\beta_c)+2\beta_c\beta_s-\tau_c\tau_s))-h_s^2\tau_c^2(3\tau_c\tau_s+\beta_c^2-2\beta_c\beta_s)>0.\end{aligned}$$

Solving the inequality for h_s gives two indifference curves.

$$\begin{aligned}h_s^W\equiv&\frac{\tau_c\tau_s+\beta_sr_c-\beta_s\tau_c}{\tau_c}+\frac{(\tau_c\tau_s-\beta_c\beta_s)(\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s}{\tau_c(2(\tau_c\tau_s-\beta_c\beta_s)+\beta_c^2+\tau_c\tau_s)}\\&\pm\frac{|\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s|)}{\tau_c(2(\tau_c\tau_s-\beta_c\beta_s)+\beta_c^2+\tau_c\tau_s)}\end{aligned}$$

The second solution
$h_{s|2}^W\equiv\frac{\tau_c\tau_s+\beta_sr_c-\beta_s\tau_c}{\tau_c}+\frac{(\tau_c\tau_s-\beta_c\beta_s)(\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s-|\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s|)}{\tau_c(2(\tau_c\tau_s-\beta_c\beta_s)+\beta_c^2+\tau_c\tau_s)}$ is below or equal to $h_s^{\min}\equiv\frac{\tau_c\tau_s+\beta_sr_c-\tau_c\beta_s}{\tau_c}$ if

$$\frac{(\tau_c\tau_s-\beta_c\beta_s)(\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s-|\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s|)}{\tau_c(2(\tau_c\tau_s-\beta_c\beta_s)+\beta_c^2+\tau_c\tau_s)}\leq 0$$
$$\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s-|\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s)|\leq 0.$$

If $\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s>0$ then $h_{s|2}^W=h_s^{\min}$. If $\beta_c(2r_c-(2\tau_c-\beta_c))+2\beta_c\beta_s-\tau_c\tau_s<0$ then $h_{s|2}^W<h_s^{\min}$. As $h_{s|2}^W$ is below or equal to one of the $h_s^{\min}$ conditions it is outside the feasible area and only the first solution of $h_{s|1,2}^W$ is considered in Lemma 3.5. □

4 Data Sharing in a Hybrid Platform Market‡

Abstract

We study the implications of data sharing by a hybrid platform that can operate either as a pure marketplace or in the dual mode, i.e., as a marketplace and a seller at the same time. In the pure marketplace mode, two sellers offering substitutable products compete in prices, and the platform earns profits through a proportional marketplace fee. In the dual mode, the platform and a seller compete with substitutable products in prices. The platform can share data on consumer insights that enables sellers to increase the product valuation. We find that the platform prefers dual mode operation over the pure marketplace mode. For close substitutes and a low marketplace fee, the platform softens competition by using data exclusively. For less substitutable products or a substantial marketplace fee, it shares data with the independent seller. The platform switches to data exclusivity at a lower degree of product substitutability than in the pure marketplace mode. Mandating data sharing with sellers increases consumer surplus and welfare.

Keywords: Platforms, data sharing, vertical integration, differentiated products, self-preferencing

JEL classification: D42, L11, L40, L50

‡This chapter is based on the manuscript: M. Holler and J. Reimer (2025). Data Sharing in a Hybrid Platform Market.

4.1 Introduction

In recent years, hybrid platforms have been the subject of interest by competition authorities around the world. Hybrid platforms facilitate interactions in their marketplace. At the same time, hybrid platforms can decide to be active in their own marketplaces, competing with the firms they host. The largest e-commerce platform worldwide, *Amazon.com* is the most prominent example of a hybrid platform. It connects sellers and buyers through its marketplace. At the same time, it is also active as a seller of products under its own brand (e.g., *Amazon Basics*, *Amazon Essentials*), and thus, competes directly with the sellers in its marketplace.

The hybrid business model is especially interesting as platforms can collect extensive and precise data through their marketplace. They monitor consumer activities in their online marketplaces, such as product views, search terms, and purchasing histories. Through systematic analysis of this data, the platform can identify consumer preferences and trends. This can effectively help demand forecasting, targeted advertising, price discrimination, and tailoring products to the taste of consumers. Due to the hybrid business model, platforms can use these insights to improve their own offerings in the marketplace. They also may share these insights with the firms they host. For instance, *Amazon* collects, processes, and uses data generated in its marketplace. Through the tool *Amazon Brand Analytics* it grants access to these insights to third-party sellers. The tool consists of multiple dashboards that help sellers to understand consumer preferences (Amazon, 2022). Similarly, *Alibaba* launched the *Tmall Innovation Center* in 2017 that provides consumer insights derived from the *Alibaba* marketplace to sellers enabling them to create product improvements. Through the *Tmall Innovation Center*, the producer of the chocolate bar *Snickers*, namely, *Mars*, learned that consumers purchasing *Snickers* also have a preference for spicy snacks. Based on this insight, *Mars* developed a spicy variant of the chocolate bar to meet Chinese consumer tastes (Kerr et al., 2020).

Notably, collecting and using data is an old story: Market research through consumer surveys or scanner data recorded at the cash registers are established tools. For instance, traditional brick-and-mortar stores observe scanner data on the prices and quantities of the products sold in the stores. Hybrid platforms, on the other hand, operate in an online environment that facilitates the collection of extensive data. Unlike physical stores, platforms such as *Amazon* serve multiple product markets simultaneously. The data contains information on consumer preferences, e.g., products in the consideration set and click through rates. Thus, the digital environment makes data on consumer insights a decisive factor in competition.

A key concern for regulatory agencies is that hybrid platforms may use data to leverage their market power from the marketplace in the connected market. For instance, platforms can use the information advantage gained in its marketplace to improve its offerings in the connected market. By controlling access to data, they also decide whether or not to share consumer insights with the firms they host. Thus, data becomes a strategic lever for hybrid platforms, raising the question of level playing fields in the digital sector. This competitive advantage is particularly worrying given the gatekeeper role many online platforms enjoy. Gatekeepers typically own the core infrastructure for independent firms to be active in the market. As stated in an industry report, for 37 percent of the 2.3 million active third-party sellers on the *Amazon* marketplace, *Amazon* marketplace is the sole income source, showing the strong dependence of third-party sellers on *Amazon* (JungleScout, 2020). For these sellers, *Amazon* is the gateway to reach consumers.[1] Ultimately, the gatekeeper position strengthens the platforms' strategic advantage obtained through data control.

Until recently, it was up to the platform to decide whether or not to share data. With the introduction of the Digital Markets Act (DMA) in 2022, the European Commission aims to implement fair rules in the digital sector.[2] The DMA is the first legal framework considering data usage by gatekeeper platforms from an antitrust perspective. According to Article 6(2) of the DMA, designated gatekeepers operating in dual mode are not allowed to use non-public data generated from their own core platform activities in competition with business users. Thereby, the article aims to prevent self-preferencing. Article 6(10) of the DMA ensures that gatekeepers provide data to business users that is generated in the context of the business user's usage of the core platform service. Thus, Article 6(10) mandates data sharing of raw data by gatekeeper platforms. This chapter focuses on the sharing of information by the platform derived from data analysis, such as market trends. In particular, we consider a setup in which hybrid platforms observe consumer activities across many different sellers and product categories, such as search terms and click rates. In contrast, independent sellers see only the data they generate through their own sales. Thus, s platform's analysis draws on a broad information base, making the resulting consumer insights valuable.

In light of this, understanding the incentives of a hybrid platform to share data on consumer insights and the implications on competition, consumer surplus, and total

[1] Likewise, the app stores by *Google* and *Apple* are the gateways for app developers to reach end-users.

[2] In 2025, the designated gatekeepers by the European Commission are *Alphabet*, *Amazon*, *Apple*, *Booking*, *ByteDance*, *Meta*, *Microsoft* (European Commission, 2023).

welfare is crucial. In this chapter, we provide a theoretical framework to analyze a hybrid platform's incentives to share data on consumer insights in a setting in which access to these insights enables sellers to offer a product with higher valuation. Through its marketplace activities, the platform generates data as a by-product. Sharing data gives the platform a strategic lever to affect the product value of sellers. The analysis becomes particularly interesting when the platform becomes active in the downstream selling market. Then, the platform can affect its own and its rival's product value through data.

In our model, a platform hosts two sellers, each offering a substitutable product. While an independent seller offers one product, the other product is either sold by an independent seller or by the platform. In the former case, the platform operates under the pure marketplace mode, collecting a proportional marketplace fee. In the latter case, the platform operates under the dual mode. It competes with the independent firm in prices for the substitutable goods in the marketplace while collecting the marketplace fee. The platform has two strategic instruments: It decides on its operating mode and data-sharing regime. We also analyze how data-sharing obligations affect competition and welfare.

We find that the platform operates in the dual mode and shares data on consumer insights with the rival seller whenever products are less substitutable and the marketplace fee is substantial. Whenever products are close substitutes, the platform uses the data exclusively to avoid competition. The platform in the dual mode prices less aggressively as it earns profits through the marketplace fee when the independent seller makes sales. Consequently, the consumer suffers from higher prices when the platform operates in the dual mode compared to a setting in which the platform serves purely as a marketplace. Exclusive data use by the platform harms the consumer as it limits competition. Data sharing increases consumer surplus and total welfare as then both products offer a higher product valuation to the consumer. Combining data-sharing obligations with a ban on dual mode operations yields the highest consumer surplus and welfare.

The remaining sections are organized as follows: Section 4.2 discusses the related literature. Section 4.3 presents the theoretical setting. Subsequently, we analyze the outcomes in the pure marketplace mode, the dual mode, and we carry out the optimal operating mode decision of the platform. Section 4.4 shows how our results affect consumer surplus and total welfare. Finally, in Section 4.5, we conclude the chapter.

4.2 Related Literature

We begin the literature review with a broader overview of papers concerning online markets in regard to data use, before narrowing the focus to the optimal operating mode of hybrid platforms and, ultimately, to the role of data sharing in hybrid platform markets. This chapter aims to contribute to a better understanding of digital platform markets by modeling a hybrid platform that can choose whether to share data on consumer insight with sellers in its marketplace. In our model, data access enables sellers to increase the consumer valuation of their products.

Recent literature investigates the impact of data in digital markets. Cornière and Taylor (2024a) classify revenue shifts due to data-driven product improvement as firms' ability to enhance consumer surplus or extract a bigger share of surplus. Applying the classifications by Cornière and Taylor (2024a) to the selling market in our model shows that data usage is unilaterally pro-competitive. Having access to data increases sellers' mark-up because they charge a higher price. Thus, a marginal consumer becomes more valuable, and competition to attract a marginal consumer becomes more intensive. We build on this framework and shed light on a platform's decision whether or not to provide data access in a hybrid platform market.

Extending the framework by Cornière and Taylor (2024a), Cornière and Taylor (2024b) analyze mergers between firms in data connected markets. They consider a monopolist that generates data in one market and two rival firms with differentiated products in another market. The products of the two markets are neither substitutes nor complements, but the data generated by the monopolist can be used by the two firms in the other market. The firms can use the data to improve product quality. A merger of the monopoly and one of the firms benefits consumers in both markets, given that data sharing was restricted prior to the merger. Conversely, a merger harms consumers if data sharing was already feasible. What distinguishes our contribution from theirs is that we consider the implications of data sharing in a hybrid platform market where the markets are connected through a fee.

A closely related literature strand considers product improvements through data-driven enhancements and innovation investments in digital ecosystems. Rhodes et al. (2025) study a framework where a platform operates in numerous product market and competes in each market with a single-product firm. The platform and the firm decide on innovation investments to increase consumer utility. Additionally, the platform can leverage data generated through product sales to further enhance product valuation. They show that regulatory interventions regarding data usage and sharing create incentives for small firms to innovate more.

Krämer and Shekhar (2025) examine a related research question. In their framework, a platform monopolizes a data-generating market and competes with another platform in a connected market. Innovation efforts in the data-gathering market increase demand, which in turn can be cross-utilized to increase demand in the connected market as well. The authors analyze the implications of data usage regulations on the outcomes in the data gathering market as well as the data-connected market. They find that data sharing increases total welfare while lowering innovation incentives by the platform connecting both markets. A restriction of the cross-use of data in the different markets harms competition and welfare.

Unlike the last two papers, we focus on data-driven product improvements in a hybrid platform market. In our framework, a hybrid platform can share data with firms it competes with in the marketplace to enhance product offerings. Markets are connected through a proportional marketplace fee, which shapes the platform's incentives for data sharing. Our primary focus is on how the platform's operating mode choice, namely, pure marketplace or dual mode, affects data-sharing incentives.

This chapter is also related to the literature on platform markets. The seminal contributions by Armstrong (2006), Caillaud and Jullien (2003), and Rochet and Tirole (2003) consider platforms as pure intermediaries in light of network effects. Building on these contributions, another strand of the literature considers a platform that intermediates between different market sides and, in the hybrid mode, is also active in its marketplace, competing with the firms it hosts. Several studies investigate the pricing and operating mode strategies of such platforms (e.g., Hagiu, Teh, et al. (2022), Anderson and Bedre Defolie (2024)). We build on these insights, as the platform's pricing and operating mode choices determine the incentives for data sharing. Given its similarities to our analytical framework, we discuss in detail the model by Etro (2021) in the following.

Etro (2021) examines a model in which a hybrid platform competes with an independent seller for differentiated goods in one of his extensions. In his framework, the platform can utilize a recommendation system in order to direct all consumers towards its preferred option. Consequently, the recommended firm can sell at the monopoly price. Alternatively, the platform can let the firms compete without a recommendation system. Due to double marginalization, the platform as a monopolist charges a lower price than an independent monopolistic seller having the same cost. Therefore, the platform as a seller obtains higher profits than collecting the linear marketplace fee. Thus, the relevant comparison is between the platform's profits when it acts as a monopolist and when it faces price competition. Under price competition, Etro (2021) shows that the seller charges a higher price than the platform, given any linear marketplace fee and no recommendation system. The reason is that the platform considers the marketplace profits when setting the price. As marketplace profits increase as lower prices result in higher demand, the platform has an incentive to set a lower price. However, with a proportional fee, we can show that the platform in the dual mode charges a higher price than the seller, regardless of the data-sharing regime. Etro (2021) finds that consumers are better off under dual mode operation through product variety for a very low product substitutability compared to the platform selling at monopoly prices. Otherwise, the pure marketplace mode yields a higher consumer surplus. Our analysis differs from Etro (2021) in two important dimensions. First, we do not consider a recommendation system, which eliminates the platform's ability to sell at monopoly prices. Also, in our model, when the platform operates in the pure marketplace mode, two differentiated sellers compete in prices. This contrasts Etro (2021), where only one seller is active when the platform is a pure marketplace. In our setting, consumers are better off under the pure marketplace mode compared to dual mode. This occurs because dual mode leads to less aggressive pricing.

A very recent but fast growing literature focuses on data sharing by hybrid platforms. These papers examine hybrid platforms with different data usage applications. Closely related to our research question is Navarra et al. (2023). They investigate how a hybrid platform uses data to price discriminate in a setting where products are differentiated on a Hotelling line. The platform exploits surpluses of sellers and consumers through the marketplace fee and data sharing. Similarly to our findings, the platform avoids fierce competition through the data-sharing decision.

In other papers, data is employed as a tool to resolve demand uncertainty. For example, Madsen and Vellodi (2025) explore how a platform uses private marketplace data to identify demand for innovative products for imitation. Absent regulation, the platform imitates high demand products. By means of a ban, the platform is less informed about product demand, so that imitations spread more broadly across products. As a result, a ban fosters innovative activities for high demand products and stifles activities for middling demand products. Similarly, Lam and X. Liu (2023) examine the operating mode decision of a hybrid platform in a product market where the platform has an information advantage through marketplace data. By using private marketplace data, the platform can identify high selling products and make a more informed imitation decision. Similar to our result, sellers benefit from platform entry when competition is fierce as the platform internalizes its marketplace revenues in its pricing decision.

Markovich et al. (2025) consider a hybrid platform and a seller in reduced-form framework. In their model, there are two types of inattentive consumers. Those who will potentially purchase when aware of the products and those who are never interested. The platform cannot distinguish between different types, but the seller can. When the seller shares this information on consumer types, the platform can inform consumers about products through advertising. Information sharing obliges the platform to advertise the independent seller's offering and only the potential consumer type can be informed. In this case, the platform also decides whether to also advertise its own offering to consumers. Whenever the platform advertises both products, the platform and the seller would compete by offering substitutable products. This creates a tradeoff for the seller between increasing sales and intensifying competition through data sharing. The authors find that the seller withholds information only when product substitutability is intermediate. Otherwise, it prefers to reveal information. Like in our model, data sharing is a tool to affect the degree of competition in the marketplace. However, Markovich et al. (2025) assume the seller is in control of data access, whereas in our model, the platform decides on data sharing.

Zha et al. (2023) study a hybrid platform's incentives to share demand information with an upstream manufacturer and a competing seller in the marketplace. Under the dual mode, where the platform and seller buy the product from the manufacturer, information sharing increases double marginalization and intensifies horizontal competition, but improves efficiency. For high product substitutability, the platform shares information only with the manufacturer, as efficiency gains in the upstream market dominate, while downstream competition would become too intense. For moderate substitutability, the platform shares demand information with both parties, benefiting from the information effect and greater efficiency. For low substitutability, the platform shares information only with the seller avoiding double marginalization while horizontal competition effects remain weak. On the other hand, under the pure marketplace mode, where the manufacturer and the independent seller sell through the platform, the platform only shares demand information with the manufacturer if demand variability is moderate, competition is intense, and fulfillment costs are high. In this case, increased competition from an informed seller outweighs the information effect. Otherwise, the platform shares the demand information with both parties.

In a setting close to ours, Magnani and Navarra (2025) use data to resolve demand uncertainty for sellers. In their model, sellers are uninformed about market demand, but data sharing by the platform reveals the true demand. In the pure marketplace mode, the hybrid platform hosts two independent sellers offering differentiated products and collects a linear marketplace fee. The platform can also operate in the dual mode by making a take-it-or-leave-it offer to one of the sellers. In the dual mode, the platform is less efficient than the sellers. In the equilibrium, the platform opts for the dual mode whenever its marginal cost is sufficiently low and products are highly differentiated. In this case, the platform does not share demand information because this would make the acquisition more costly. Conversely, whenever the platform operates in the pure marketplace mode, it shares demand information. Information sharing benefits both sellers and the platform as inefficient prices set by the uninformed sellers also hurt the platform. However, it harms consumers and reduces total welfare.

While all the above mentioned papers examine situations in which the hybrid platform can use data as a strategic tool, they differ in the data application. To the best of our knowledge, our data application, namely, data-driven product improvements, has not been analyzed in a hybrid platform setting so far. Therefore, the combination of a hybrid platform that decides on its operating mode and sellers' data access that can help to increase product valuation is novel.

4.3 Model Setup

Consider a monopolistic platform G that facilitates the interaction between sellers and the consumer. We assume that intermediation entails negligible cost. There are no outside sales to emphasize the gatekeeper position of the platform.

Based on observations on online marketplaces, platform G charges an exogenous ad-valorem fee $t \in [0, 1]$ on revenues in exchange for its marketplace services.[3] For instance, consider *Amazon* that collects a common fee per product category. That is, sellers of products that belong to the product category "Toys and Games" pay 15 percent of the final consumer price per sale to *Amazon* (Amazon, n.d.). Similarly, app developers offering their apps in the *Apple* or *Google* app store face a constant proportional fee where the size of the fee depends on the overall revenues generated by a seller (The Verge, 2021; Google, n.d.). For this reason, the marketplace fee in our model is exogenous.

In our model, two sellers offer each a horizontally differentiated product in the

[3]For a discussion on the exogeneity of marketplace fees see Etro (2023).

marketplace and compete in prices. To keep the model tractable, we limit our analysis to two sellers. The marginal production cost of both sellers are standardized to zero.

Moreover, platform G is hybrid. It can either serve as a pure marketplace or become active as a seller in the dual mode. In the pure marketplace mode, platform G solely facilitates the interaction between the consumer and two independent sellers, generating profits through the marketplace fee t. In the dual mode, platform G hosts an independent seller in its marketplace while competing in prices with the seller. The platform vertically integrates with independent seller 1 in order to become active as a seller in the dual mode.[4] The platform's marginal cost are also standardized to zero.

We employ a linear quadratic utility function, where product-specific valuations are incorporated. Throughout the model, a seller with access to data on consumer insights tailors the product based on consumer preferences. As a results, the consumer experiences a higher product valuation. For example, the marketplace collects data on search terms that indicates that consumers look for yellow vases while white vases are barely considered. Thus, a seller with access to this data learns that consumers prefer yellow vases to white ones. Consequently, the seller changes the color of the vase, and a consumer likes the product more.

A consumer's utility from consuming quantities q_i and q_j of the two substitutable products where $i, j = 1, 2$ with $i \neq j$, is

$$U = q_0 + (V + \delta_i k)q_i + (V + \delta_j k)q_j + \frac{q_i + q_j}{1 - \beta} - \frac{q_i^2 + 2\beta q_i q_j + q_j^2}{2(1 - \beta^2)}, \qquad (4.1)$$

where q_0 is the numeraire good. The standardized parameter $\beta \in (0, 1)$ captures the products' degree of substitutability. The products of the two sellers are close substitutes for high values of β. In these situations, rivalry between sellers is intense. We denote the intrinsic product valuation with $V > 1$.[5] In our model, data-driven product improvements translate into a linear increase of the product value. Formally, we denote the data-driven product improvement by $k > 0$, which represents the utility gain seller i can attain if the platform shares data on consumer preferences with seller i. We consider situations in which data represents information on aggregated consumer insights, such as market trends.

[4] Since the sellers are symmetric, it does not matter for the outcome whether G vertically integrates with seller 1 or 2. Thus, this assumption is without loss of generality.

[5] The condition $V > 1$ ensures that prices decrease in the substitutability parameter β as argued in the proof of Statement 4.1 in the Appendix A4.1.

We assume that data is a by-product obtained through the platform's marketplace activities at no cost. Through data analysis, the platform can provide consumer insights to sellers, for instance through analytical dashboards or reports. The insights reflect consumer preferences at an aggregated level.

The data variable, $\delta_i = \{0, 1\}$, is a dummy indicating whether or not the platform shares the data on consumer insights with seller i. As a tie-breaking assumption, we assume that if G is indifferent between the outcomes under data sharing and exclusive data access, it will share data. If data is shared with a seller, the seller improves its product according to consumer preferences, which increases product valuation. Thus, we look at situations where data is not an essential input to compete but creates a competitive advantage in the selling business. In our model, we consider the extreme case where, without data sharing, the seller is completely uninformed about how to change its offering to better meet consumer preferences and, therefore, cannot improve its product.

Each consumer faces the budget constraint $M = q_0 + p_i q_i + p_j q_j$, where the price of the numeraire good q_0 is normalized to 1 and the price of seller i is captured in p_i. Consumer's utility maximization yields the demand for seller i's product

$$q_i = \omega + \delta_i k - p_i - \beta(\delta_j k - p_j), \tag{4.2}$$

where $\omega \equiv 1 + V(1 - \beta)$.[6] The demand for product i is higher if seller i has access to data on consumer insights, i.e., $\delta_i = 1$, and hence the seller improves the product by k. Contrary, if the rival seller j has access to data and thereby improves its offering, this has a negative effect on demand for seller i since seller j offers a higher-valued product than it would without data access.

The timing of the game is as follows:

Stage 1. Platform G decides on its operating mode: pure marketplace or dual mode.

Stage 2. G decides whether to share data with the seller(s): δ_i and δ_j.

Stage 3. Seller(s) and, if applicable, G compete in consumer prices p_i.

Stages 2 and 3 are solved for the pure marketplace mode in Section 4.3.1 and for the dual mode in Section 4.3.2. Section 4.3.3 discusses the decision on the platform's optimal operating mode.

[6] We assume that the product valuation exceeds the product improvement, i.e., $1 + V(1 - \beta) > k$. This assumption fits the idea of data-driven product improvements that provide incremental enhancements.

4.3.1 Pure Marketplace

We begin our analysis by examining the outcome when platform G has decided to serve as a pure marketplace (denoted by P), earning profits solely through the proportional marketplace fee $t \in [0, 1]$. In this case, two symmetric sellers compete by setting their prices. Using the demand function (4.2), the profit function of seller i reads

$$\pi_i^P = (1-t)p_i\Big(\omega + \delta_i k - p_i - \beta(\delta_j k - p_j)\Big). \tag{4.3}$$

Note that seller i can only improve the product if i can access data. In stage 3, the sellers compete in prices. Solving for the first-order conditions, the corresponding equilibrium price is

$$p_i^P = \frac{(2+\beta)\omega + (2-\beta^2)\delta_i k - \beta\delta_j k}{4-\beta^2}. \tag{4.4}$$

Note that the price in (4.4) is independent of the marketplace fee, t. This result comes from standardizing the marginal cost to zero. In a model with a positive marginal cost, the fee affects prices through the fee-adjusted marginal cost. Introducing a positive marginal cost would show this dependence.

If the platform decides to share data on consumer insights with both sellers, it sets $\delta_1 = \delta_2 = 1$, which we denote by the superscript B in the following. Under an exclusive data-sharing regime, the platform shares data with one seller. Given that sellers are symmetric, when platform G chooses to share data exclusively with one of the sellers, it is indifferent whether to share it with seller 1 or 2. As a tie-breaking assumption, we assume that data is shared with seller 1, i.e., $\delta_1 = 1$ and $\delta_2 = 0$, in this case.[7] We refer to this outcome by E. Under exclusive data access, the seller with consumer insights provides a product with higher consumer utility than without consumer insights. Finally, we denote the outcome by N when the platform decides to share data with neither firm, i.e., $\delta_1 = \delta_2 = 0$.

When setting prices, sellers take into account the degree of product substitutability. As products become closer substitutes, competition intensifies, causing prices to fall.[8] In contrast, the price of a seller increases in k whenever the seller gets access to data. We find that under exclusive data access the increase in seller 1's price is larger due to a change in k compared to the situation where G shares data with

[7] Under exclusivity, we turn to a situation where sellers may no longer be symmetric due to the data-sharing regime and, therefore, we name seller 1 and seller 2 explicitly.

[8] This statement, referred to as Statement 4.1, is specified in the Appendix A4.1.

both sellers. Under exclusivity, products 1 and 2 differ in terms of their product values, creating the possibility for seller 1 to charge a higher price and extract larger parts of the additional consumer utility. In contrast, when both sellers have access to data, seller 1 takes into account the effect of the rival's product improvement in its pricing. The effect intensifies with increasing β. Likewise, seller 2 incorporates in its price setting the positive effect of its own product improvement and the negative effect of seller 1's product improvement. The price of seller 2, p_2^{PE}, decreases in k whenever data is not shared with seller 2 but with seller 1. In this case, seller 2 compensates for the lack of product improvement by setting a lower price. In conclusion, the sign and the intensity of the overall effect of a marginal unit of product improvement, k, on prices vary across different data-sharing regimes.[9] The resulting prices are ordered by level in Lemma 4.1.

Lemma 4.1. *The relations* $p_1^{PE} > p_1^{PB} = p_2^{PB} > p_1^{PN} = p_2^{PN} > p_2^{PE}$ *hold.*

Proof. See Appendix A4.1. □

We find that seller 1 charges the highest price, p_1^{PE}, among all price settings in the different data-sharing regimes when it has exclusive access to data. A situation where both firms have access to data results in the highest price set by seller 2, p_2^{PB}, which in this case is equal to seller 1's price, p_1^{PB}. The lowest price of seller 2, p_2^{PE}, results when seller 1 has access to data, but seller 2 does not. This price is lower than the prices charged by sellers 1 and 2 if no seller has data access, $p_1^{PN} = p_2^{PN}$.

Substituting the prices (4.4) into the profit function (4.3) yields seller i's profit

$$\pi_i^P = (1-t)\frac{\Big((2+\beta)\omega + (2-\beta^2)\delta_i k - \beta\delta_j k\Big)^2}{(4-\beta^2)^2}. \tag{4.5}$$

Seller i's profit depend crucially on the platform's data-sharing regime, namely, δ_i and δ_j. Seller i benefits from having access to data.[10] Therefore, from a seller's perspective, having access to data is welcomed.

Now, we move to the second stage where platform G in the pure marketplace mode decides whether or not to share its marketplace data. The platform collects

[9] However, in a setting where firms compete on the Hotelling line, data sharing with both sellers and data sharing with no sellers yields identical prices in equilibrium. This follows from standard competition in a Hotelling type model with symmetric utility functions, where prices equal marginal cost plus transportation cost. Therefore, prices increase only under exclusive data-sharing arrangements in the Hotelling model. Our setting, in contrast, enables the platform to extend demand by increasing utility through data sharing, which yields economically more interesting results.

[10] This statement, referred to as Statement 4.2, is specified in the Appendix A4.1.

a fraction t of the sellers' revenues, earning $\pi_G^P = t(p_1 q_1 + p_2 q_2)$. After inserting the sellers' prices, we obtain

$$\pi_G^P = t\Big(\frac{\big((2+\beta)\omega + (2-\beta^2)\delta_1 k - \beta\delta_2 k\big)^2}{(4-\beta^2)^2} + \frac{\big((2+\beta)\omega + (2-\beta^2)\delta_2 k - \beta\delta_1 k\big)^2}{(4-\beta^2)^2}\Big). \tag{4.6}$$

The first term in parentheses in equation (4.6) shows the revenue of seller 1. The second term represents the revenue of seller 2. As a pure marketplace, platform G aims to maximize industry revenues. Thus, when G decides to share data on consumer insights with seller 1, it considers the implications on seller 2's revenue. Next, we compare the platform profits under different data-sharing regimes. Because of the binary character of the data-sharing parameters, δ_i and δ_j, the platform's maximization problem in (4.6) can be solved by analyzing platform profits for all possible data-sharing configurations.

By considering first the difference in profits between sharing data with both sellers and sharing with neither, we find that $\pi_G^{PB} > \pi_G^{PN}$. Thus, G as a pure marketplace prefers sharing data with both sellers rather than not sharing it. Second, comparing the platform's profits from sharing data exclusively to not sharing data shows that $\pi_G^{PE} > \pi_G^{PN}$. Thus, the revenue that G obtains from seller 1 increases more than the revenue from seller 2 decreases in the exclusive setting. Consequently, G in the pure marketplace mode shares data with at least one seller.

Finally, comparing π_G^{PB} and π_G^{PE} yields ambiguous results. The sign of the profit difference depends on the degree of product substitutability. The more substitutable the products are, the stronger the impact of data sharing with seller 1 on seller 2. If products are close substitutes, intense competition absorbs the additional rents from seller 2's product improvements. Thus, in this case, the platform prefers to share data exclusively with seller 1. Based on these comparisons, Lemma 4.2 summarizes our findings.

Lemma 4.2. *The relation* $\min(\pi_G^{PB}, \pi_G^{PE}) > \pi_G^{PN}$ *holds. It holds that* $\pi_G^{PB} \geq \pi_G^{PE}$ *if* $2(2+\beta)^2(1-\beta)\omega + (2+\beta)^2(1-\beta)^2 k - 2(2-\beta^2)\beta k \geq 0$. *Otherwise, the relation* $\pi_G^{PB} < \pi_G^{PE}$ *holds.*

Proof. See Appendix A4.1. □

We find that the platform prefers to share data with both sellers or exclusively with one seller over not sharing data at all. The platform's rationale is that sellers can capture part of the additional consumer's utility from product improvement through their prices, which in turn increases their revenues. As a result, platform profits also increase.[11] However, whether the platform prefers to share data with both sellers or with one seller is less straightforward. Lemma 4.2 implies that whenever product substitutability is sufficiently low, platform G prefers sharing data with both sellers over exclusive data access to seller 1. The reason is that when products are less substitutable, competition is weak, and sellers can set higher prices. In this case, the intuition from the price discussion applies. If seller 2 has access to data, the negative effect of the product improvement of seller 2 on seller 1's price is less intense for low values of β. In this case, sharing data with both sellers is a more attractive strategy for platform G because the direct positive effect of k on seller 1's price is strong and offsets the negative effect of k.

Recall that $\beta \in (0, 1)$. In what follows, we explore the implications of β on the data-sharing decision. Consider the limit case of $\beta \to 0$, where products are perceived to be independent. In this case, the platform's maximization problem consists of two independent components, the revenues from sellers 1 and 2. The platform's objective to maximize marketplace profits coincides with the profit maximization of sellers 1 and 2.[12] Thus, the platform shares data with both sellers in the limit case of independent markets.

By contrast, for intermediate values of β, data sharing with one seller affects the profit of the other seller. For higher values of β, competition between sellers becomes fierce. The intensive competition dampens the profit increase that G experiences through data sharing. It turns out that when data is shared with seller 1 exclusively, the dampening effect of β on platform profits is less intense when both sellers obtain data access.[13] Thus, by giving only seller 1 data access, the platform can reduce competitive pressure in these situations.

In the limit case of $\beta \to 1$, products become perfect substitutes. As such, competition is very fierce, which limits the sellers' ability to extract the additional utility the consumer obtains through product improvements. In this case, the platform can avoid fierce competition by sharing data exclusively with seller 1. The findings are summarized in Proposition 4.1.

Proposition 4.1. *In the pure marketplace mode, the platform shares data on con-*

[11] However, this result is not without loss of generality. If the platform incurs fixed costs of data sharing, it may prefer not to share data with sellers when these costs are sufficiently high.

[12] Notice that this observation is fundamentally linked to our assumption on zero marginal cost of production. Thus, if sellers incurred a constant marginal cost of production, there could be, in some cases, a misalignment between the maximization problems of sellers and platform, which might lead to different results.

[13] This statement, referred to as Statement 4.3, is proven in the Appendix A4.1.

sumer insights exclusively with a seller whenever products are sufficiently close substitutes. Otherwise, the platform shares data with both sellers.

To sum up, under the pure marketplace mode, we find that G's profits decrease in the product substitutability parameter β. The rate of the decrease, however, varies across the data-sharing regime. Platform G's profits decrease more in β when it shares data with both sellers than under exclusive data sharing. The more substitutable products are, the lower the positive effect of data sharing with seller 2 on G's profits because competitive forces are too strong. In these cases, platform G uses exclusive data access to avoid fierce competition in the marketplace.

4.3.2 Dual Mode

Under the dual mode *(D)*, platform G vertically integrates with seller 1. In this case, the platform hosts independent seller 2 and collects a fraction t of its revenues. At the same time, G competes with seller 2 for substitutable products in prices in the marketplace. As a seller, the platform does not have to pay the marketplace fee because this would equal a transfer within the platform business. As data access increases the platform's demand at no cost, G will use the information obtained through its marketplace unit. Therefore, G's data-sharing decision only concerns whether or not to share data with seller 2.

We start the analysis by considering price competition between platform G and independent seller 2 in stage 3. In the dual mode, the platform maximizes

$$\pi_G^D = p_G\Big(\omega + k - p_G - \beta(\delta_2 k - p_2)\Big) + tp_2\Big(\omega + \delta_2 k - p_2 - \beta(k - p_G)\Big)$$

with respect to p_G. The profit function of the platform consists of two terms. The first term represents the selling profit, and the second term refers to a fraction of the revenues collected from seller 2. When platform G acts in the dual mode, the independent seller maximizes

$$\pi_2^D = (1-t)p_2\Big(\omega + \delta_2 k - p_2 - \beta(k - p_G)\Big)$$

with respect to p_2. The platform's equilibrium price is

$$p_G^D = \frac{\Big(2 + \beta(1+t)\Big)\omega + \Big(2 - \beta^2(1+t)\Big)k - (1-t)\beta\delta_2 k}{4 - (1+t)\beta^2}, \tag{4.7}$$

and the price of seller 2 is

$$p_2^D = \frac{(2+\beta)\omega + (2-\beta^2)\delta_2 k - \beta k}{4-(1+t)\beta^2}. \tag{4.8}$$

We find that both prices increase in marketplace fee t.[14] The platform raises its price in response to an increase in the exogenously given marketplace fee t because collecting marketplace profits becomes more appealing. As a result, the platform is inclined to compete less aggressively in the selling business. In response, seller 2 also sets a higher price.

Next, we investigate the effect of the change in the market structure due to dual mode operation on the price of independent seller 2. To do so, consider the situation in which platform G serves as a pure marketplace and seller 2 competes with independent seller 1. Furthermore, assume that seller 1 has data access similar to the platform in the dual mode. In this case, seller 2 sets the price (4.4) where $\delta_1 = 1$. It turns out that this price is lower than the price seller 2 sets when G operates in the dual mode given in (4.8). Thus, by becoming active under the dual mode, platform G relaxes price competition.

We now compare the price setting under different data-sharing regimes in the dual mode. In particular, platform G has two options. G can share data on consumer insights with seller 2 by setting $\delta_2 = 1$. In this case, both firms, G and seller 2 have access to data and improve the product valuation. We denote this outcome by B. Alternatively, G can use data exclusively, in this case, $\delta_2 = 0$. We refer to this outcome by E. Lemma 4.3 states the price ranking from prices in the different data-sharing regimes in the dual mode.

Lemma 4.3. *The relations* $p_G^{DE} > p_G^{DB} > p_2^{DB} > p_2^{DE}$ *hold.*

Proof. See Appendix A4.1. □

Across the two data-sharing regimes, we find that the price of the platform under the dual mode is higher than the price of the independent seller. The platform sets the highest price if it uses data exclusively. In this case, platform G offers a product that yields higher consumer utility, which G extracts through its price. Under the dual mode, when G and seller 2 have access to data, G sets a higher price than seller 1 would when G operated in the pure marketplace mode as platform G internalizes the revenues of seller 2 when setting its price. Therefore, the optimal price of the platform is higher than the independent seller's price. The lowest price is charged

[14] This statement, referred to as Statement 4.4, is proven in the Appendix A4.1.

by seller 2 if the seller has no access to consumer insights while G benefits from a information advantage. In this case, seller 2 sets the lower price to compensate for the lack of product improvement.

Inserting the prices (4.7) and (4.8) into the platform's profit function yields

$$\begin{aligned}\pi_G^D =& \frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k - \beta(1-t)\delta_2 k\Big)^2}{\big(4-(1+t)\beta^2\big)^2} \\ &- t\beta\frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k - \beta(1-t)\delta_2 k\Big)\Big((2+\beta)\omega - \beta k + (2-\beta^2)\delta_2 k\Big)}{\big(4-(1+t)\beta^2\big)^2} \\ &+ t\frac{\Big((2+\beta)\omega - \beta k + (2-\beta^2)\delta_2 k\Big)^2}{\big(4-(1+t)\beta^2\big)^2}. \end{aligned} \tag{4.9}$$

The first and the second term in equation (4.9) represent the profit G obtains from selling the good, whereas the third term shows the marketplace profit of G through t. The independent seller profit is

$$\pi_2^D = (1-t)\frac{\Big((2+\beta)\omega - \beta k + \delta_2(2-\beta^2)k\Big)^2}{\big(4-(1+t)\beta^2\big)^2}. \tag{4.10}$$

When seller 1 were to benefit from a data advantage, namely, $\delta_1 = 1$, comparing seller 2's profits across the different operating modes in equations (4.10) and (4.5) reveals that the seller prefers dual mode operation due less aggressive pricing.

The platform compares the profits in different settings to determine the optimal data-sharing regimes. The findings are stated in Lemma 4.4.

Lemma 4.4. *The relation $\pi_G^{DB} \geq \pi_G^{DE}$ holds if*

$$\begin{aligned}&\Big(t(2-\beta^2)\big(4-(1+t)\beta^2\big) - (1-t)\beta\big(4+2\beta-t\beta^2\big)\Big)\omega \\ &+ \Big(t(2-\beta^2)\big(2-4\beta-\beta^2+(1+t)\beta^3\big) - (1-t)\beta\big(4-(1+t)\beta-(2+t)\beta^2+t\beta^3\big)\Big)k \geq 0\end{aligned}$$

Otherwise, the relation $\pi_G^{DB} < \pi_G^{DE}$ holds.

Proof. See Appendix A4.1. □

With a higher marketplace fee, the revenues of seller 2, of which platform G collects a fraction t, become more important. In these cases, G is incentivized to share data with seller 2 as this leads to higher revenues for seller 2. We show that whenever marketplace fee t increases, the left-hand side of the inequality stated in Lemma 4.4 increases as well.

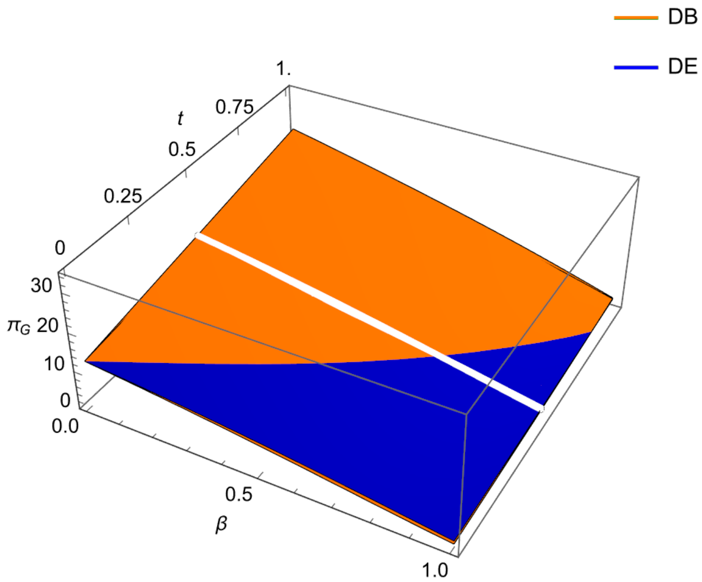
Now, consider the extreme case where $t = 0$. In this case, the platform cannot extract a fraction of seller 2's revenues, and G is only interested in selling the product itself. Consequently, G uses data exclusively to exploit the competitive advantage. However, in the opposite case, where $t = 1$, G extracts all revenues of seller 2. As a result, G's incentive to provide data on consumer insights to seller 2 increases. And, indeed, it turns out that the inequality stated in Lemma 4.4 holds.

Next, consider the limit cases of β. When $\beta \to 0$, platform G and seller 2 operate in independent markets and platform G is exposed to no competition. Instead, it only benefits through higher revenues collected via t. Thus, G has a sharp incentive to share data with seller 2. We find that the inequality stated in Lemma 4.4 holds in this case. On the contrary, whenever $\beta \to 1$, the overall sign of the inequality in Lemma 4.4 is less straightforward. In the situation where goods are prefect substitutes and the marketplace fee is sufficiently small, G can use exclusive data access to avoid competition. In these cases, marketplace profits make up a small part of total profits. Whenever $\beta \to 1$ and t is sufficiently high, it turns out that data sharing makes the platform better off than using data exclusively.

For a better understanding of the role of the marketplace fee t and the substitutability parameter β, we show platform profits π_G^{DB} and π_G^{DE} in Figure 4.1. Platform profits depend on t and β while we set $V = 5$ and $k = 1$.[15] The orange plane represents platform profits when G shares data with the independent seller 2. The blue plane demonstrates platform profits when G uses data exclusively. The white line indicates a marketplace fee of 1/2. For all combinations of β and t where the orange plane overlaps the blue plane, platform profits are higher with data sharing. When the blue plane lies above the orange plane, platform profits are higher when using data exclusively. For a high degree of substitutability β, it is more attractive for the platform to use data exclusively than sharing data with seller 2. The higher the marketplace fee t is, the more profitable it is to collect a fraction of the revenue from seller 2. In these cases, the platform has a higher incentive to share data with seller 2 as doing so increases the revenue of seller 2.

[15] We provide further numerical variations of Figure 4.1 with different levels of k in Figure 4.6 in Appendix A4.2. We find that the observations do not change qualitatively.

Figure 4.1: Platform Profits in Dual Mode



Platform profits in the dual mode for different data-sharing regimes, where $V = 5$ and $k = 1$. DB denotes the outcome where the platform in the dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively.

Proposition 4.2 summarizes our findings.

Proposition 4.2. *In the dual mode, the platform uses data on consumer insights exclusively whenever products are close substitutes and the marketplace fee is sufficiently low. Otherwise, the platform shares data with the independent seller.*

Equipped with the subgame perfect outcomes in the pure marketplace mode and the dual mode, we can now analyze the operating mode decision of the platform in the next section.

4.3.3 Optimal Mode

In stage 1, the platform decides on its operating mode. Platform G can operate in the pure marketplace mode and collect profits through its marketplace fee t. Alternatively, platform G can operate in the dual mode by merging with seller 1. For reasons of tractability, we assume that the merger is costless. In this case, G competes with the seller it hosts in its marketplace. In this section, for reasons of tractability, we restrict our analysis to the scenario where the platform's proportional fee t does not exceed $1/2$. However, one could think about this assumption as a guarantee for the sellers to be able to operate. For example, sellers need a minimum share of revenues to pay corporate taxes, remunerate investors, or cover entry cost. The platform can therefore collect up to half of the sellers' revenue, but no more.[16]

Under both modes of operation, the platform uses exclusive access to data on consumer insights as a strategic tool to soften competition. However, which degree of product substitutability triggers exclusivity is different for pure marketplace mode and dual mode. Lemmas 4.2 and 4.4 define the optimal data-sharing regimes under the different modes of operation. Lemma 4.2 states the condition under which platform G in the pure marketplace mode prefers sharing data on consumer taste with both sellers over solely with seller 1. Lemma 4.4 states the condition under which the platform in the dual mode prefers sharing data with seller 2 over using it exclusively. We find that if the condition in Lemma 4.4 holds, then the condition in Lemma 4.2 also holds. However, if the condition Lemma 4.4 does not hold the condition in Lemma 4.2 can hold.[17] The platform switches from data sharing to exclusive data access at a lower degree of product substitutability in the dual mode than in the pure marketplace mode. This demonstrates the platform's incentive to self-preference in its data-sharing choice. We find that the platform prefers to operate in the dual mode over collecting pure marketplace profits, i.e., $\max(\pi_G^{PB}, \pi_G^{PE}) < \max(\pi_G^{DB}, \pi_G^{DE})$.[18] Proposition 4.3 states our findings.

Proposition 4.3. *The platform acts in the dual mode for $t < 1/2$.*

To understand the intuition behind Proposition 4.3, we compare the equilibrium outcomes in all three situations: data sharing in both modes, exclusivity in both modes, and data sharing with both sellers in the pure marketplace mode, while platform G uses data exclusively in the dual mode.

First, suppose that platform G in the dual mode opts for data sharing. Comparing these profits with those obtained by G as a pure marketplace with data sharing shows that the profits G earns from selling the good itself exceed fraction t of the revenues it collects from seller 1. Furthermore, a fraction t of the revenues collected from seller 2 in the dual mode exceeds that of seller 2 in the pure marketplace mode. As dual mode operation relaxes price competition, revenues increase in this case.

Next, suppose that platform G adopts an exclusive data-sharing policy under both modes. In this case, we can show that the profits from selling in the dual mode are

[16] In reality, we observe that *Amazon* charges marketplace fees that vary between 8% and 45% depending on the product category (Amazon, n.d.). In the *Apple App Store*, fees are between 10% and 27% plus an additional processing fee of 3% in the EU (Apple, n.d.). In the *Google Play Store*, fees are 15% or 30% depending on the revenue of the app developer (Google, n.d.).

[17] This statement, referred to as Statement 4.5, is proven in the Appendix A4.1.

[18] This statement, referred to as Statement 4.6, is proven in the Appendix A4.1.

higher than collecting a fraction t of the revenues from seller 1. In addition, the platform collects more revenues from seller 2 in the dual mode than in the pure marketplace mode. In these cases, the higher price due to dual mode operation increases revenues.

Finally, whenever the platform in the dual mode uses data exclusively, it makes a higher total profits than when data is shared with both sellers in the pure marketplace mode.[19]

Figure 4.2 illustrates the profits platform G obtains in the pure marketplace mode and the dual mode under different data-sharing regimes depending on the intensity of rivalry β. In the numerical example, we set $V = 5$, $k = 1$, and $t = 1/3$.[20] The continues green line indicates the outcome when the platform shares data with both sellers. The dashed red line shows the equilibrium outcome where the platform shares data exclusively with one seller in the pure marketplace mode. The dashed-dotted purple line refers to the pure marketplace profits without data sharing. The dotted orange line indicates the platform profits when data is shared with seller 2, and the wide-dashed blue line indicates the outcome in a situation where the platform in the dual mode uses data exclusively.

As can be seen, dual mode operation leads to higher platform profits. Competition between sellers is intense whenever products are close substitutes. We find that the platform shares data in both operating modes when products are less substitutable. However, under the dual mode, the platform favors exclusive data access over data sharing at an intermediate level of product substitutability. In the pure marketplace mode, on the contrary, the platform switches from sharing data with both sellers to sharing data exclusively with one seller for a high degree of substitutability.

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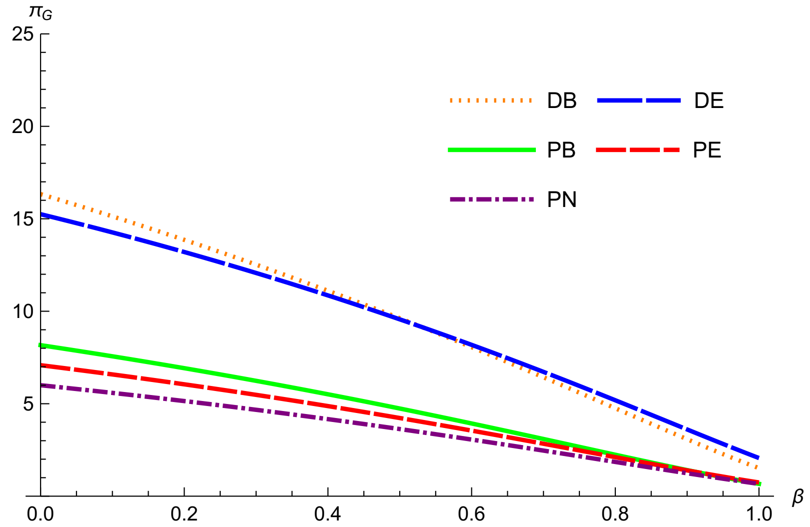
[19] Note that we can exclude a comparison where platform G in the dual mode shares data with both sellers and exclusivity in the pure marketplace mode, as such an outcome will not arise in equilibrium.

[20] An extension of Figure 4.2 to a three dimensional plot where $t \in [0, 1]$ is shown in the Appendix A4.2.

Figure 4.2: Platform Profits in Pure Marketplace and Dual Mode



Platform profits in the pure marketplace mode and dual mode for different data-sharing regimes, where $V = 5$, $k = 1$, and $t = 1/3$. DB denotes the outcome where the platform in the dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively. PB denotes the outcome where the pure marketplace shares data with both sellers. PE denotes the outcome where the pure marketplace shares data one seller exclusively. PN denotes the outcome where the pure marketplace shares data no seller.

In the analysis so far, we have assumed that the platform can decide on data sharing without any restriction. In Section 4.4, we examine how data-sharing obligations affect consumer surplus and total welfare.

4.4 Welfare Analysis

In this section, we examine the effect of different data-sharing regimes on both consumer surplus and total welfare. Furthermore, we discuss the implications of obligations forcing the platform to share data on consumer insights with the sellers in the marketplace.

4.4.1 Consumer Surplus

The implications of the respective data-sharing regime on consumer surplus are twofold. First, data-driven product improvements directly increase consumer utility. Second, sellers extract parts of the additional utility through their prices. We have shown in lemmas 4.1 and 4.3 that a seller charges a higher price with access to data than without. Furthermore, a seller with exclusive access to data will charge a higher price compared to a situation where both sellers, or neither, have access to data.

These results hold for the pure marketplace mode as well as for the dual mode. The higher prices resulting from data access reduce consumer surplus. Moreover, the extent to which the platform and sellers can extract the additional utility generated by the product improvement depends on the platform's operating mode and the data-sharing regime.

We disentangle the effects of data sharing and the platform's operating mode on consumer surplus in the following. We find that the overall effect of an increase in k on consumer surplus is positive.[21] The direct effect of k on consumer utility offsets the negative effect of the prices. Recall that G shares data with both sellers under both operating modes for a low product substitutability. However, when data is shared with both sellers, prices are higher when platform G operates in the dual mode than in the pure marketplace mode. Thus, the consumer prefers the pure marketplace mode. Lemma 4.5 summarizes our results.

Lemma 4.5. *It holds that* $CS^{PB} > \max\left(CS^{PE}, CS^{PN}, CS^{DB}, CS^{DE}\right)$ *and* $CS^{DB} > CS^{DE}$.

Proof. See Appendix A4.1. □

We find that data sharing with sellers is better from a consumer perspective, given that platform G has already made its decision about its operating mode. From a consumer perspective, comparing the different data-sharing regimes and operating modes gives a sharp result in favor of the pure marketplace mode and data sharing with both sellers. The reasons are twofold. Firstly, the prices in pure marketplace mode are lower than in the dual mode, and secondly, data sharing yields a higher utility. Therefore, the pure marketplace with data sharing with both sellers is the best outcome from a consumer perspective. Comparing this to the equilibrium outcome described in Section 4.3.3 where the platform operates under the dual mode, shows a misalignment of the platform's and consumer's interests.

In the equilibrium, platform G opts for the dual mode. In this case, the consumer prefers a situation where data is shared with both sellers. In fact, the platform's decision on data sharing is consistent with consumer interests unless products are close substitutes and the marketplace fee is low, as discussed in Proposition 4.2. The platform prefers to use data exclusively for sufficiently substitutable products and a low marketplace fee. In these situations, obligations to share data with sellers increases consumer surplus.

[21] A proof of this statement follows directly from the respective consumer surplus under different data-sharing regimes presented in the proof of Lemma 4.5.

Proposition 4.4. *Data-sharing obligations increase consumer surplus. Combining data-sharing obligations with a ban on dual mode operation yields additional gains in consumer surplus.*

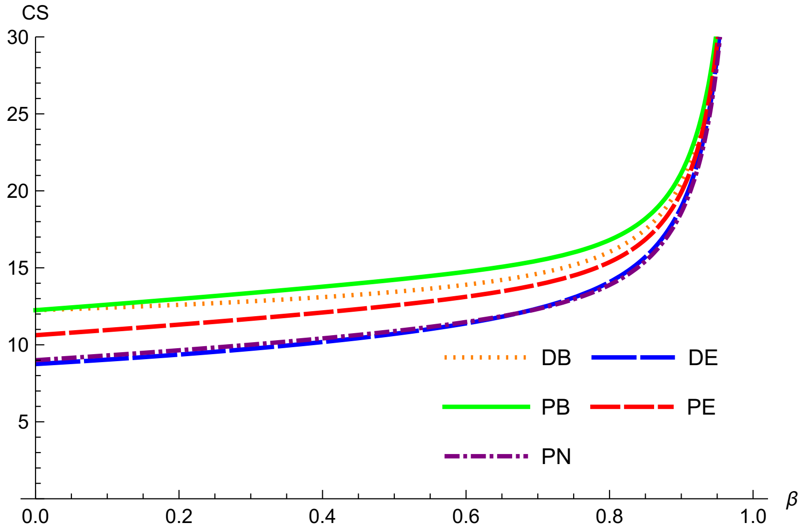
Data-sharing obligations are not sufficient to obtain the most preferred consumer surplus, namely, CS^{PB}, in our setup. The reason is that even with data-sharing obligations, the platform prefers the dual mode operation over the pure marketplace mode.[22] Consequently, consumer surplus amounts to CS^{DB} when platform G in the dual mode is obliged to share data with both sellers. In order to obtain the highest equilibrium outcome for the consumer, CS^{PB}, both data-sharing obligations and a ban on dual mode operation, which effectively restricts the platform to operate as a pure marketplace, are required.[23]

Figure 4.3 shows the consumer surplus under the different operating modes and data-sharing regimes depending on the degree of product substitutability. The continuous green line represents consumer surplus in a situation where the platform operates as a pure marketplace and shares data with both sellers, and the red line represents the consumer surplus in the pure marketplace mode under data exclusivity. The dashed purple line shows consumer surplus in a situation where G chooses the pure marketplace mode without data sharing. The dashed orange line shows consumer surplus whenever platform G operates in the dual mode and shares data with its competitor. The blue line shows consumer surplus where G operates in the dual mode under exclusivity. The highest consumer surplus is obtained if the platform acts in the pure marketplace mode and data is shared with both sellers. We find that data sharing leads to higher consumer surplus than exclusive sharing or usage in both operating modes. Consumer surplus rises as products are more substitutable due to intensive price competition.

[22] A proof of $\pi_G^{PB} < \pi_G^{DB}$ can be found in proof of Statement 4.6 part (i) in the Appendix A4.1.

[23] In our model, a sole ban on dual mode operation does not yield in CS^{PB} as the platform in the pure marketplace mode opts for exclusivity whenever products are sufficiently close substitutes as argued in Proposition 4.1.

Figure 4.3: Consumer Surplus



Consumer surplus under different modes of operation and different data-sharing regimes, where $V = 5$, $k = 1$, and $t = 1/3$. DB denotes the outcome where the platform dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively. PB denotes the outcome where the pure marketplace shares data with both sellers. PE denotes the outcome where the pure marketplace shares data one seller exclusively. PN denotes the outcome where the pure marketplace shares data no seller.

A comparison of the figures 4.2 and 4.3 shows the misalignment between the platform's incentives and consumer surplus. The platform operates in the dual mode, therefore, consumer surplus is lower than the highest available outcome, namely, CS^{PB}. Whenever products are less substitutable, the platform acts in the dual mode and shares data with its competitor. This outcome leads to the second highest available consumer surplus, namely, CS^{DB}, given our parameterization. However, for more substitutable products, the platform prefers not to share data with its competitor. In this case, the platform still operates in the dual mode but uses data exclusively. The resulting consumer surplus, namely, CS^{DE}, is illustrated by the dashed blue line. Consumer surplus suffers as a result of the platform's decision to operate in the dual mode and share data exclusively in these cases.

4.4.2 Welfare

In this section, we examine the implications of the platform's choices regarding its operating mode and data-sharing regime on total welfare where total welfare is the sum of profits of the active sellers, the platform, and the consumer surplus. In Section 4.4.1, we demonstrate that the platform's and the consumer's interests may be misaligned. We find that policymakers can address this misalignment through data-sharing obligations in combination with a ban on dual mode operation.

Before we start with the welfare analysis, consider the profits of independent seller 2 first. The seller obtains the highest profits when platform G acts in the dual mode and shares data with the seller as stated in Lemma 4.6.

Lemma 4.6. *It holds that* $\pi_2^{DB} > \max\left(\pi_2^{PB}, \pi_2^{PE}, \pi_2^{PN}, \pi_2^{DE}\right)$ *and* $\pi_2^{PB} > \pi_2^{PE}$*.*

Proof. See Appendix A4.1. □

To explore the results of Lemma 4.6, we first examine the implications of data sharing on the profits of seller 2. Notice that data-sharing obligations do not affect the platform's optimal operating mode choice. Platform G prefers dual mode operation as stated in Proposition 4.3. However, as shown in Proposition 4.2, whenever products are close substitutes and the marketplace fee is low, the platform in the dual mode prefers exclusive data usage. Otherwise, the platform shares data on consumer insights with seller 2 on a voluntary basis. Whenever products are close substitutes and the marketplace fee is low, data-sharing obligations intervene and force the platform to share data with the independent seller. Consequently, the seller benefits as its data disadvantage mitigates. Combining data-sharing obligations with a ban on dual mode operation yields a worse outcome for seller 2 than a sole ban on data sharing. As our results suggest, a sole ban on dual mode operation leads to data sharing absent any regulation in many instances. Only if products are very substitutable, the platform will prefer exclusivity in the pure marketplace, which harms seller 2. Since the seller benefits when data is shared, and dual mode operation relaxes price competition, the seller prefers data-sharing obligations and dual mode operation. In conclusion, while seller 2 benefits from data-sharing obligations, it is harmed by a ban on dual mode operation.

Next, we analyze the total welfare in the different operating modes and data regimes. A comparison yields the following lemma.

Lemma 4.7. *It holds that* $W^{PB} > \max\left(W^{PE}, W^{PN}, W^{DB}, W^{DE}\right)$ *and* $W^{DB} > W^{DE}$*.*

Proof. See Appendix A4.1. □

Note that lemmas 4.5 and 4.7 suggest a similar ranking in favor of data sharing with all sellers. Sharing insights on consumer trends increases the product valuation, thereby increasing total welfare. From this perspective, sharing data with both sellers increases product valuation the most. As stated in Lemma 4.7, from a welfare perspective, sharing data with both sellers yields higher total welfare than exclusive access to data or no data sharing at all, given the platform's choice of operation. Comparing the degree of competition under both modes, namely, pure marketplace mode and dual mode, under the same data-sharing regime reveals that the price-dampening effect of data sharing is more intense in the pure marketplace mode. Overall, we find that the scenario where the platform opts for the pure marketplace mode and shares data with both sellers yields the highest total welfare. This result is summarized in Proposition 4.5.

Proposition 4.5. *Data-sharing obligations increase total welfare. Combining data-sharing obligations with a ban on dual mode operation yields additional gains in total welfare.*

From a welfare perspective, it is preferred to force the platform to share data with its competitors. However, data-sharing obligations are insufficient to obtain the highest welfare in our setup because the platform would still act in the dual mode. In order to obtain the highest equilibrium welfare, namely, W^{PB}, a combination of of data-sharing obligations and a ban on dual mode operation is required, which effectively restricts the platform to operate as a pure marketplace.

4.5 Conclusion

Online platforms collect vast amounts of data which is a key input for firms to understand consumers' preferences. However, the hybrid business model of online platforms poses challenges for policymakers in ensuring fair level playing fields, particularly, in light of data access.

We study a theoretical framework to analyze the implications of data sharing in a hybrid platform setting. The platform as a pure marketplace hosts two sellers offering substitutable products. The sellers compete in product prices and can improve their product whenever the platform provides data access on consumer insights. We find that the platform shares data with at least one seller. If sellers' products are less substitutable, the platform shares data with both sellers. For close substitutes, the platform shares data with one seller exclusively to relax competition in the marketplace.

Alternatively, in the dual mode, the platform acts as both a marketplace and a seller. The platform and the independent seller compete in prices. The platform has access to data that enables product improvement, while the independent seller depends on the platforms choice to share data. If products are less substitutable and the marketplace fee is substantial, the platform shares data with its rival. The platform switches from data sharing with the seller to exclusive data usage at a lower degree of product substitutability in the dual mode than in the pure marketplace mode. This reveals that the platform has a stronger incentive to withhold data when it competes with the seller, demonstrating self-preferencing in the platform's data-sharing choice. As the platform in the dual mode engages in competition with the independent seller, it can leverage its strategic access to data to gain a competitive advantage.

The comparison of the different modes of operation reveals that the platform prefers to operate under dual mode over collecting pure marketplace profits. Dual mode operation leads to a lower consumer surplus and welfare compared to the outcome when the platform acts as a pure marketplace due to higher prices. Therefore, a ban on dual mode operation increases consumer surplus. Furthermore, exclusive data access reduces consumer surplus and total welfare. We show that, regardless of the operating mode of the platform, data-sharing obligations raise consumer surplus. Finally, a combination of data-sharing obligations and a ban on dual mode operation increases consumer surplus and total welfare.

A4.1 Proofs of Statements and Lemmas

Proof of Statement 4.1.
Statement 4.1 claims that p_i^P decrease in β. Differentiating p_i^P in (4.4) where $\omega \equiv 1 + (1 - \beta)V$ with respect to (w.r.t.) β yields

$$\frac{\partial p_i^P}{\partial \beta} = \frac{(2+\beta)^2(1-V) - k\Big(4\beta\delta_i + (4+\beta^2)\delta_j\Big)}{(4-\beta^2)^2} < 0$$

for $0 < \beta < 1$, $k > 0$, and if $V > 1$. Therefore, we assume $V > 1$ throughout the model. □

Proof of Lemma 4.1.
Differentiating p_i^P in (4.4) w.r.t. k yields

$$\frac{\partial p_i^P}{\partial k} = \frac{(2-\beta^2)\delta_i - \beta\delta_j}{4-\beta^2},$$

where the sign of the derivative above depends on the data-sharing regime.

Inserting the respective data-sharing regime in (4.4) yields the sellers' prices. Whenever platform G shares data with both sellers, substituting $\delta_1 = 1$ and $\delta_2 = 1$ in (4.4), yields

$$p_1^{PB} = p_2^{PB} = \frac{(2+\beta)\omega + (2-\beta-\beta^2)k}{4-\beta^2}. \tag{4.11}$$

The effect of k on p_1^{PB} and p_2^{PB} is

$$\frac{\partial p_1^{PB}}{\partial k} = \frac{\partial p_2^{PB}}{\partial k} = \frac{2-\beta-\beta^2}{4-\beta^2} > 0.$$

When the platform shares data exclusively with seller 1, substituting $\delta_1 = 1$ and $\delta_2 = 0$ in (4.4) yields the prices for seller 1 and 2, respectively. The price of seller 1 equals

$$p_1^{PE} = \frac{(2+\beta)\omega + (2-\beta^2)k}{4-\beta^2} \tag{4.12}$$

and the price of seller 2 is

$$p_2^{PE} = \frac{(2+\beta)\omega - \beta k}{4-\beta^2}. \tag{4.13}$$

Differentiating p_1^E and of p_2^{PE} w.r.t. k yields

$$\frac{\partial p_1^{PE}}{\partial k} = \frac{2-\beta^2}{4-\beta^2} > 0, \quad \text{and} \quad \frac{\partial p_2^{PE}}{\partial k} = -\frac{\beta}{4-\beta^2} < 0.$$

When platform G decides against data sharing, substituting $\delta_1 = 0$ and $\delta_2 = 0$ in (4.4), prices are

$$p_1^{PN} = p_2^{PN} = \frac{(2+\beta)\omega}{4-\beta^2} \tag{4.14}$$

and differentiating p_1^{PN} and p_2^{PN} w.r.t. k yields

$$\frac{\partial p_1^{PN}}{\partial k} = \frac{\partial p_2^{PN}}{\partial k} = 0.$$

An increase in k increases $p_1^{PB}, p_2^{PB}, p_1^{PE}$, decreases p_2^{PE}, and has no effect on p_1^{PN}. Note that $\frac{\partial p_1^{PB}}{\partial k} < \frac{\partial p_1^{PE}}{\partial k}$. Ranking the prices (4.11) - (4.14) by size yields $p_1^{PE} > p_1^{PB} = p_2^{PB} > p_1^{PN} = p_1^{PN} > p_2^{PE}$. □

Proof of Statement 4.2.

Statement 4.2 claims that seller i's profit (4.5) is higher when $\delta_i = 1$ compared to when $\delta_1 = 0$, i.e., $\pi_i^P(\delta_i = 1) > \pi_i^P(\delta_i = 0)$. To explore the effect of data sharing on seller i's profit we substitute in $\delta_i = 1$ and $\delta_i = 0$ in $\pi_i^P(\delta_i = 1) - \pi_i^P(\delta_i = 0) > 0$. The inequality holds if

$$(1-t)\frac{\Big((2+\beta)\omega + (2-\beta^2)k - \beta\delta_j k\Big)^2}{(4-\beta^2)^2} - (1-t)\frac{\Big((2+\beta)\omega - \beta\delta_j k\Big)^2}{(4-\beta^2)^2} > 0.$$

Both terms have the same positive denominator and are multiplied with $(1-t)$ which is also positive. Thus, we focus on the expressions in the numerators and the expression of interest is

$$\Big((2+\beta)\omega + (2-\beta^2)k - \beta\delta_j k\Big)^2 - \Big((2+\beta)\omega - \beta\delta_j k\Big)^2 > 0.$$

After rearranging the term yields

$$(2-\beta^2)k\Big(2(2+\beta)\omega + (2-\beta^2-2\beta\delta_j)k\Big) > 0.$$

This inequality holds given that either $\delta_j = 0$ or $\delta_j = 1$. As the inequality holds and it is proportional to the profit difference the relation $\pi_i^P(\delta_i = 1) > \pi_i^P(\delta_i = 0)$

holds. □

Proof of Lemma 4.2.
Whenever G shares data with both sellers, substituting $\delta_1 = 1$ and $\delta_2 = 1$ into the profit function of the platform in (4.6) yields

$$\pi_G^{PB} = 2t\frac{\Big((2+\beta)(\omega+(1-\beta)k)\Big)^2}{(4-\beta^2)^2}. \tag{4.15}$$

When G shares data solely with seller 1, we substitute $\delta_1 = 1$ and $\delta_2 = 0$ in (4.6), and obtain

$$\pi_G^{PE} = t\left(\frac{\Big((2+\beta)\omega+(2-\beta^2)k\Big)^2+\Big((2+\beta)\omega-\beta k\Big)^2}{(4-\beta^2)^2}\right). \tag{4.16}$$

When G does not share data with sellers 1 and 2, substituting $\delta_1 = 0$ and $\delta_2 = 0$ in (4.6), yields

$$\pi_G^{PN} = 2t\frac{\Big((2+\beta)\omega\Big)^2}{(4-\beta^2)^2}. \tag{4.17}$$

In the pure marketplace mode, is immediate that platform profits are higher when G shares data with both sellers than with no seller, i.e., $\pi_G^{PB} > \pi_G^{PN}$ holds given $0 < \beta < 1$ and $\omega > k > 0$.

In the pure marketplace mode, platform profits are higher when G shares data with one seller compared to sharing data with no seller if $\pi_G^{PE} - \pi_G^{PN} > 0$. The profit function (4.15) and (4.17) have the same positive denominator. Therefore, we focus on the sign of the expressions in the numerator. The inequality holds if

$$2(2+\beta)^2(1-\beta)\omega+\Big((2-\beta^2)^2+\beta^2\Big)k > 0.$$

The inequality holds given our parameter specifications. As the inequality holds and it is proportional to the profit difference, $\pi_G^{PE} > \pi_G^{PN}$ holds.

In the pure marketplace, platform profits are higher or equal when G shares data with both sellers compared to exclusive data sharing with seller 1 if $\pi_G^{PB} - \pi_G^{PE} \geq 0$. The inequality holds if

$$2(2+\beta)^2(1-\beta)\omega+(2+\beta)^2(1-\beta)^2k-2(2-\beta^2)\beta k \geq 0. \tag{4.18}$$

In fact, there are cases where this inequality does not hold. To see this, consider the limit cases of the left-hand side (LHS) of (4.18). When $\beta \to 0$ the LHS of (4.18) is $4(2(1+V)+k) > 0$ since $k > 0$ and $V > 1$. Therefore, the inequality (4.18) holds in this case. In contrast, when $\beta \to 1$, the LHS of (4.18) is $-2k < 0$ and the inequality (4.18) does not hold. To examine the effect of β on the condition in (4.18) further, we take the derivative w.r.t. β.

$$\begin{aligned}\frac{\partial LHS(4.18)}{\partial \beta} &= 2\Big(2(2+\beta)(1-\beta) - (2+\beta)^2\Big)(1+V(1-\beta)) - 2V(2+\beta)^2(1-\beta) \\ &+ \Big(2(2+\beta)(1-\beta)^2 - 2(2+\beta)^2(1-\beta) - 2(2-\beta^2) + 4\beta^2\Big)k\end{aligned}$$

We are interested in the sign of the derivative. After rearranging, the derivative reads

$$\begin{aligned}\frac{\partial LHS(4.18)}{\partial \beta} &= -6(2+\beta)\beta\omega - 2V(2+\beta)^2(1-\beta) \\ &- 2\Big(2(2-\beta^3) + 3\beta(1-2\beta)\Big)k. \end{aligned} \tag{4.19}$$

The terms $-6(2+\beta)\beta\omega$ and $-2V(2+\beta)^2(1-\beta)$ are clearly negative. However, the sign of the term in parentheses in front of k is not clear. Throughout the model $\omega > k$. Thus, in order to show that the expression (4.19) is negative, it is sufficient to show that the sum of the terms in front of ω and k is negative. The sum of interest is $-6(2+\beta)\beta - 2(2(2-\beta^3) + 3\beta(1-2\beta))$. Rearranging gives $-6(3-\beta)\beta - 4(2-\beta^3) < 0$, which clearly holds. Thus, the right-hand side (RHS) of (4.19) is negative. Therefore, the LHS of (4.18) decreases in β. □

Proof of Statement 4.3.
Statement 4.3 claims that the effect of β on π_G^{PE} is stronger than on π_G^{PB}. Under exclusivity, the platform earns π_G^{PE} in (4.16). When platform G in the pure marketplace mode shares data with both sellers, it earns π_G^{PB} in (4.15). We show that $\frac{\partial \pi_G^{PB}}{\partial \beta} < \frac{\partial \pi_G^{PE}}{\partial \beta}$. To this end, first consider the derivatives of each term w.r.t. β where $\omega \equiv 1 + (1-\beta)V$.

$$\frac{\partial \pi_G^{PB}}{\partial \beta} = \frac{4t\Big(\omega + (1-\beta)k\Big)(1-V-k)}{(2-\beta)^3} < 0$$

$$\frac{\partial \pi_G^{PE}}{\partial \beta} = \frac{2t\Big((2+\beta)^3\Big((1-V)(2\omega + (1-\beta)k) - k\omega\Big) - k^2\beta(4-5\beta^2)\Big)}{(4-\beta)^3} < 0$$

The relation $\frac{\partial \pi_G^{PB}}{\partial \beta} < \frac{\partial \pi_G^{PE}}{\partial \beta}$ holds if

$$\frac{4t\Big(\omega + (1-\beta)k\Big)(1-V-k)}{(2-\beta)^3} < \frac{2t\Big((2+\beta)^3\Big((1-V)(2\omega+(1-\beta)k)-k\omega\Big)-k^2\beta(4-5\beta^2)\Big)}{(4-\beta)^3}.$$

Rearranging yields

$$-\Big(2(1-\beta)V+\beta\Big)(2+\beta)^3-\Big((1-\beta)(16+19\beta+7\beta^2+2\beta^3)+\beta\Big)k<0.$$

This inequality holds given our parameter specifications and, hence, $\frac{\partial \pi_G^{PB}}{\partial \beta} < \frac{\partial \pi_G^{PE}}{\partial \beta}$.
□

Proof of Statement 4.4.
Statement 4.4 claims that p_G^D and p_2^D increase in marketplace fee t. Differentiating p_G^D in (4.7) w.r.t. t yields

$$\frac{\partial p_G^D}{\partial t} = 2\beta \frac{(2+\beta)\,\omega - \beta k + (2-\beta^2)\delta_2 k}{\Big(4-(1+t)\beta^2\Big)^2} > 0.$$

Thus, p_G^D increases in t.

Differentiating the p_2^D in (4.8) w.r.t. t yields

$$\frac{\partial p_2^D}{\partial t} = \beta^2 \frac{(2+\beta)\omega + (2-\beta^2)\delta_2 k - \beta k}{\Big(4-(1+t)\beta^2\Big)^2} > 0.$$

Thus, p_2^D increases in t. □

Proof of Lemma 4.3.
Inserting the respective data-sharing regime in (4.7) and (4.8) yields the price of the platform and the one of seller 2, respectively. As argued in the main text, platform G in the dual mode does always use data. Whenever G shares data with seller 2, i.e., $\delta_2 = 1$, the price of G is

$$p_G^{DB} = \frac{\Big(2+\beta(1+t)\Big)\Big(\omega+(1-\beta)k\Big)}{4-(1+t)\beta^2}, \tag{4.20}$$

and the price of seller 2 is

$$p_2^{DB} = \frac{(2+\beta)\Big(\omega+(1-\beta)k\Big)}{4-(1+t)\beta^2}. \tag{4.21}$$

When G uses data exclusively, i.e., $\delta_2 = 0$, the price of G is

$$p_G^{DE} = \frac{\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k}{4-(1+t)\beta^2}, \tag{4.22}$$

and the price of seller 2 under exclusivity is

$$p_2^{DE} = \frac{(2+\beta)\omega - \beta k}{4-(1+t)\beta^2}. \tag{4.23}$$

Ranking the prices (4.20) - (4.23) by size yields $p_G^{DE} > p_G^{DB} > p_2^{DB} > p_2^{DE}$. □

Proof of Lemma 4.4.
Inserting the data-sharing regimes into the profit function of the platform (4.9) yields the different profit functions. Whenever G shares data with seller 2, i.e., $\delta_2 = 1$, the platform profits are

$$\begin{aligned}\pi_G^{DB} =& \frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k - \beta(1-t)k\Big)^2}{\big(4-(1+t)\beta^2\big)^2} \\ &- t\beta\frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k - \beta(1-t)k\Big)\Big((2+\beta)\omega - \beta k + (2-\beta^2)k\Big)}{\big(4-(1+t)\beta^2\big)^2} \\ &+ t\frac{\Big((2+\beta)\omega - \beta k + (2-\beta^2)k\Big)^2}{\big(4-(1+t)\beta^2\big)^2}.\end{aligned} \tag{4.24}$$

When G uses data exclusively, i.e., $\delta_2 = 0$, platform G earns

$$\begin{aligned}\pi_G^{DE} =& \frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k\Big)^2}{\big(4-(1+t)\beta^2\big)^2} \\ &- t\beta\frac{\Big(\big(2+\beta(1+t)\big)\omega + \big(2-\beta^2(1+t)\big)k\Big)\Big((2+\beta)\omega - \beta k\Big)}{\big(4-(1+t)\beta^2\big)^2} \\ &+ t\frac{\Big((2+\beta)\omega - \beta k\Big)^2}{(4-(1+t)\beta^2)^2}.\end{aligned} \tag{4.25}$$

In the dual mode, platform profits are higher with data sharing compared to exclusive data usage if $\pi_G^{DB} - \pi_G^{DE} \geq 0$. The inequality holds if

$$\Big(t(2-\beta^2)\big(4-(1+t)\beta^2\big)-(1-t)\beta(4+2\beta-t\beta^2)\Big)\omega \\ +\Big(t(2-\beta^2)\big(2-4\beta-\beta^2+(1+t)\beta^3\big)-(1-t)\beta\big(4-(1+t)\beta-(2+t)\beta^2+t\beta^3\big)\Big)k \geq 0. \tag{4.26}$$

In fact, this inequality does not hold for all parameterizations. We provide further characterizations of the expression in the following. Taking the derivative of the LHS of (4.26) w.r.t. t and simplifying yields

$$\begin{aligned}\frac{\partial LHS(4.26)}{\partial t} &= (1+\beta)\big(4(2-\beta-t\beta^2)+(1+2t)\beta^3\big)\omega \\ &+ (1+\beta)(1-\beta)\big(2(2-t\beta^2)(1-\beta)+\beta^3\big)k > 0\end{aligned}$$

since $2-\beta-t\beta^2 > 0$, $2-t\beta^2 > 0$, $0 < \beta < 1$, and $0 \leq t \leq 1$. Thus, the LHS of(4.26) increases in t. To analyze (4.26) further, we substitute the extreme case where $t = 0$ in (4.26) and find $-\beta(2(2+\beta)\omega+(4-\beta-2\beta^2)k) < 0$. Thus, platform G prefers data exclusivity if $t = 0$. In contrast, if $t = 1$, (4.26) yields $(2-\beta^2)^2(2\omega+(1-2\beta)k) > 0$. Thus, platform G prefers to share data if $t = 1$. Finally, we consider the limit cases of β on (4.26). The limit of the LHS of (4.26) if $\beta \to 0$ is $4t(2(1+V)+k) > 0$. Thus, platform G prefers to share data with seller 2. On the contrary, if $\beta \to 1$ the LHS of (4.26) is $-k-2(3-5t+t^2)$, where the sign is ambiguous. In the parameter range $0 < t < 1$, $-k-2(3-5t+t^2)$ strictly increases in t. Thus, consider the extreme case of $t = 0$ the expression is $-(6+k) < 0$. In this case, platform G prefers to share data exclusively. Considering the other extreme case, where $t = 1$ the expression is $2-k > 0$ since $\lim_{\beta\to 1} 1+V(1-\beta) = 1 > k$. Thus, platform G prefers to share data if $\beta \to 1$ and $t = 1$. □

Proof of Statement 4.5.
Statement 4.5 claims that if the condition in Lemma 4.4 holds, then the condition in Lemma 4.2 also holds. However, if the condition in Lemma 4.4 does not hold the condition in Lemma 4.2 can hold. This statement holds if the inequality $LHS(4.18) > LHS(4.26)$ holds. The inequality holds if

$$\begin{aligned}&2(2+\beta)^2(1-\beta)\omega+(2+\beta)^2(1-\beta)^2k-2(2-\beta^2)\beta k \\ &> \Big(t(2-\beta^2)\big(4-(1+t)\beta^2\big)-(1-t)\beta(4+2\beta-t\beta^2)\Big)\omega \\ &+\Big(t(2-\beta^2)\big(2-4\beta-\beta^2+(1+t)\beta^3\big)-(1-t)\beta\big(4-(1+t)\beta-(2+t)\beta^2+t\beta^3\big)\Big)k.\end{aligned}$$

After rearranging such that only the RHS depends on t the inequality reads

$$(2-\beta^2)\Big(2(2+\beta)\omega+(2-2\beta-\beta^2)k\Big) > t(1+\beta)\Big((2-\beta)(4-\beta^2)+\beta^2\Big(2(1-t)+\beta t\Big)\Big)\omega \\ + t(1-\beta^2)\Big((4-\beta^2 t)(1-\beta)+\beta^3\Big)k. \quad (4.27)$$

To prove this statement, first, notice that the LHS is independent of t whereas the RHS depends on t. Differentiating the RHS of (4.27) and simplifying yields

$$\frac{\partial RHS(4.27)}{\partial t} = (1+\beta)\Big((2-\beta)^2(2+\beta)+\beta^2\Big(2(1-2t)+2t\beta\Big)\Big)\omega \\ + (1-\beta^2)\Big((1-\beta)(4-\beta^2(1+2t))+\beta^2\Big)k > 0$$

given $0 < \beta < 1$ and $0 \leq t \leq 1/2$. Note that we restrict our attention from section 4.3.3 onward for tractability reasons to the parameter range $0 \leq t \leq 1/2$. As the RHS of (4.27) increases in t, we consider the upper bound of t by inserting $t = 1/2$ in (4.27). After substituting and rearranging, the inequality stated in (4.27) reads

$$(2+\beta)\Big(8-3\beta^2(1+\beta)\Big)\omega + \Big(4(2-2\beta-\beta^2)-3\beta^2(1-\beta)(1+\beta)^2\Big)k > 0. \quad (4.28)$$

First notice that the function before ω is positive. Second, throughout the model, $\omega > k$. Thus, to show that the expression presented in (4.28) is positive, it is sufficient to show that the sum of terms before ω and k are positive. Formally,

$$(2+\beta)\Big(8-3\beta^2(1+\beta)\Big) + \Big(4(2-2\beta-\beta^2)-3\beta^2(1-\beta)(1+\beta)^2\Big) > 0.$$

Rearranging yields

$$12(2-\beta^2-\beta^3)+\beta^2(3\beta^3-1) > 0$$

which holds for $0 < \beta < 1$. Thus, (4.28) holds and also (4.27) is satisfied. Therefore, if the condition in Lemma 4.4 holds, then the condition in Lemma 4.2 also holds. However, if the condition in Lemma 4.4 does not hold the condition in Lemma 4.2 can hold. □

Proof of Statement 4.6.
Statement 4.6 claims that the platform prefers to operate in the dual mode over collecting pure marketplace profits, i.e., $\max(\pi_G^{PB}, \pi_G^{PE}) < \max(\pi_G^{DB}, \pi_G^{DE})$. First, we identify the profits to be compared. Platform profits under the pure marketplace

mode in (4.6) can be expressed in terms of the respective prices and quantities as

$$\pi_G^P = t\Big(p_1^P q_1^P + p_2^P q_2^P\Big).$$

Note that quantities in the pure marketplace mode are derived by substituting the price expressions in (4.5) into the quantity expression (4.2) yields

$$q_i^P = \frac{(2+\beta)\omega + (2-\beta^2)\delta_i k - \beta\delta_j k}{4-\beta^2}. \tag{4.29}$$

Under the dual mode, platform profits in (4.9) can be expressed in terms of the respective prices and quantities as

$$\pi_G^D = p_G^D q_G^D + t p_2^D q_2^D.$$

Substituting the price expressions in (4.7) and (4.8) into the quantity expressions yields

$$\begin{aligned} q_G^D = &\frac{\Big(2+\beta(1+t)\Big)\omega + \Big(2-\beta^2(1+t)\Big)k - \beta(1-t)\delta_2 k}{4-(1+t)\beta^2} \\ &- \beta t \frac{(2+\beta)\omega - \beta k + (2-\beta^2)\delta_2 k}{4-(1+t)\beta^2} \end{aligned} \tag{4.30}$$

and

$$q_2^D = \frac{(2+\beta)\omega - \beta k + (2-\beta^2)\delta_2 k}{4-(1+t)\beta^2}. \tag{4.31}$$

Platform G operates in the dual mode if $\pi_G^D > \pi_G^P$ which can be rewritten as

$$p_G^D q_G^D + t p_2^D q_2^D > t\Big(p_1^P q_1^P + p_2^P q_2^P\Big). \tag{4.32}$$

We show that the inequality in (4.32) holds in three steps. The first step involves proving that $p_G^D > p_1^P$. The second step proves that $q_G^D > t q_1^P$. The first and second steps ensure that the platform obtains higher profits from selling compared to the profits it collects as a pure marketplace from seller 1. Finally, we need to show that $p_2^D q_2^D > p_2^P q_2^P$. This is step 3, which shows that the revenues G collects in the dual mode exceed those G collects in the pure marketplace mode from seller 2. We perform all three steps for all possible combinations of data-sharing regimes.

Part (i) $\pi_G^{DB} > \pi_G^{PB}$

Note that $\pi_G^{DB} > \pi_G^{PB}$ is satisfied if $p_G^{DB} > p_1^{PB}$, $q_G^{DB} > tq_1^{PB}$ and $p_2^{DB}q_2^{DB} > p_2^{PB}q_2^{PB}$ hold. First, inspection of p_G^{DB} in (4.20) and p_1^{PB} in (4.11) reveals that $p_G^{DB} > p_1^{PB}$ holds. Second, the inequality $q_G^{DB} > tq_1^{PB}$ holds if

$$\Big((2-\beta)\Big(2(1-(1+\beta)t\Big)+\beta(1-\beta t))+\beta^2t^2\Big)(\omega+(1-\beta)k)>0,$$

which is true since $0 < \beta < 1$ and $0 \leq t \leq 1/2$. Finally, in step 3, inspection of p_2^{DB} in (4.21) and p_2^{PB} in (4.11) reveals that $p_2^{DB} > p_2^{PB}$ holds. Likewise, $p_2^{DB}q_2^{DB} > p_2^{PB}q_2^{PB}$ holds. Hence, $\pi_G^{DB} > \pi_G^{PB}$ holds.

Part (ii) $\pi_G^{DE} > \pi_G^{PE}$

Note that $\pi_G^{DE} > \pi_G^{PE}$ is satisfied if $p_G^{DE} > p_1^{PE}$, $q_G^{DE} > tq_1^{PE}$ and $p_2^{DE}q_2^{DE} > p_2^{PE}q_2^{PE}$ hold. First, inspection of p_G^{DE} in (4.22) and p_1^{PE} in (4.12) reveals that $p_G^{DE} > p_1^{PE}$ holds. Next, the inequality $q_G^{DE} > tq_1^{PE}$ holds if

$$\begin{aligned}&\Big((4-\beta^2)\Big(2+\beta-t(2+2\beta+\beta^2)\Big)+\beta^2t^2(2+\beta)\Big)\omega\\&+(2-\beta^2)\Big((4-\beta^2)(1-t)+\beta^2t^2\Big)k>0.\end{aligned}\tag{4.33}$$

The expression stated above consists of two parts. The sign of the first part, namely, $((4-\beta^2)(2+\beta-t(2+2\beta+\beta^2))+\beta^2t^2(2+\beta))\omega$ is not immediately obvious, while the sign of the second part, $(2-\beta^2)((4-\beta^2)(1-t)+\beta^2t^2)k$, is positive. Thus, to prove that the inequality above is positive, we focus on the first part of the inequality. However, notice that within the first term $(2+\beta-t(2+2\beta+\beta^2))$ contains the only negative component. To show that this is positive, substitute $t = 1/2$ to get the smallest value of this expression which yields $1 - 1/2\beta^2 > 0$. Thus, the inequality (4.33) holds and we conclude that $q_G^{DE} > tq_1^{PE}$. Finally, the inspection of p_2^{DE} in (4.23) and p_2^{PE} in (4.13) reveals that $p_2^{DE} > p_2^{PE}$ holds. Likewise, $p_2^{DE}q_2^{DE} > p_2^{PE}q_2^{PE}$ holds. Hence, $\pi_G^{DE} > \pi_G^{PE}$ holds.

Part (iii) $\pi_G^{DE} > \pi_G^{PB}$

As there is no clear ranking of p_2^{DE} and p_2^{PB}, we compare π_G^{DE} in (4.25) directly with π_G^{PB} in (4.15). We find that $\pi_G^{DE} - \pi_G^{PB} > 0$ holds if

$$\begin{aligned}&(2-\beta)^2\Big(\Big((2+\beta)^2(1-t)-t\beta^2((2+\beta)+(1+\beta)t)\Big)\omega^2\Big)\\&+(2-\beta)^2\Big(\Big((2+\beta)(2(2-\beta^2)-t(2+\beta)(4-3\beta))-\beta^2t(2-\beta^2)+\beta^3t^2(1+\beta)\Big)\omega k\Big)\end{aligned}$$

$$+ (2-\beta)^2\Big(\big((2-\beta^2)^2 - t(1-\beta)(8-5\beta^2-\beta^3)\big)k^2\Big)$$
$$+ 2t^2\beta^2\Big(8-(2+t)\beta^2\Big)\Big(\omega+(1-\beta)k\Big)^2 > 0. \tag{4.34}$$

The sign of (4.34) is proportional to the sign of $\pi_G^{DE} - \pi_G^{PB}$. Thus, in the following, we determine the sign of (4.34). To this end, we focus on each term in the inequality separately.

Consider the first term of (4.34). While $(2-\beta)^2$ is clearly positive, it is not immediate obvious that $(2+\beta)^2(1-t) - t\beta^2((2+\beta)+(1+\beta)t) > 0$. Thus, in the following, we focus on $(2+\beta)^2(1-t) - t\beta^2((2+\beta)+(1+\beta)t)$. The expression in question decreases in t. Thus, by substituting $t = 1/2$ we obtain the smallest value of the expression, which is $(2-3/4\beta^2)(1+\beta) > 0$. Thus, the first term of (4.34) is positive.

The second term in (4.34) is positive if

$$2(2+\beta)(2-\beta^2) > t\Big((2+\beta)^2(4-3\beta) + \beta^2(2-\beta^2) - \beta^3(1+\beta)t\Big). \tag{4.35}$$

where we rearranged the second term in (4.34) so that the LHS is independent of t whereas the RHS depends on t. Differentiating the RHS of (4.35) yields

$$\frac{\partial RHS(4.35)}{\partial t} = (2+\beta)^2(4-3\beta) + \beta^2(2-\beta^2) - 2\beta^3(1+\beta)t,$$

which is linear in t. Thus, substituting the two extreme values for t indicates the sign of the derivative within the respective parameter range. For $t = 0$, the derivative is clearly positive. For $t = 1/2$, the derivative becomes $(2+\beta)(2(2+\beta)(2-\beta) - \beta(2+\beta^2)) - \beta^4 > 0$ which holds. Thus, the RHS of (4.35) increases in t. As a next step, we substitute $t = 1/2$ into the inequality in (4.35) to increase the RHS as much as possible which then yields the strictest condition. This yields $8 - \beta(4+\beta) + 3\beta^3 > 0$ which is clearly positive. Thus, we can conclude that the sign of the second term of (4.34) is positive.

Next, we show that the third term in (4.34) is positive where $(2-\beta^2)^2 - t(1-\beta)(8-5\beta^2-\beta^3)$ determines the sign. It follows immediately that the expression in question decreases in t. Thus, we substitute $t = 1/2$ and obtain $(2-\beta^2)^2 - 1/2(1-\beta)(8-5\beta^2-\beta^3)$. Rewriting this yields $1/2\beta(8-3\beta-4\beta^2+\beta^3) > 0$. Thus, the third term of (4.34) is positive.

Finally, the last term of (4.34) is positive since $(8-(2+t)\beta^2) > 0$.

Hence, combining these results shows that $\pi_G^{DE} > \pi_G^{PB}$ holds.

Part (iv) $\pi_G^{DB} > \pi_G^{PE}$
Fourth, $\pi_G^{DB} > \pi_G^{PE}$ is not required to be proven since the platform uses data exclusively in the dual mode whenever it decides to share data exclusively in the pure marketplace mode (see proof of Statement 4.5). □

Proof of Lemma 4.5.
Consumer surplus is defined as

$$CS = U - M. \tag{4.36}$$

where U is the utility stated in (4.1) and $M = q_o + p_1q_1 + p_2q_2$ is the budget constraint. Whenever platform G acts as a pure marketplace and shares data with both sellers, substituting the prices (4.11) and the respective quantities from (4.29) into the consumer surplus (4.36) yields

$$CS^{PB} = \frac{\Big(\omega + (1-\beta)k\Big)^2}{(1-\beta)(2-\beta)^2}.$$

When G acts as a pure marketplace and shares data with seller 1 exclusively, substituting the prices in (4.12) and (4.13) and the respective quantities from (4.29) into the consumer surplus (4.36) yields

$$CS^{PE} = \frac{2(2+\beta)^2\omega^2 + 2(2+\beta)^2(1-\beta)\omega k + (1-\beta)(4-3\beta^2)k^2}{2(1-\beta)(2-\beta)^2(2+\beta)^2}.$$

When G acts as a pure marketplace and does not share data with the sellers, substituting the prices (4.14) and respective quantities from (4.29) into the consumer surplus (4.36) yields

$$CS^{PN} = \frac{\omega^2}{(1-\beta)(2-\beta)^2}.$$

When G acts in the dual mode and shares data with seller 2, substituting the prices in (4.20) and (4.21) and the quantities in (4.30) and (4.31) into the consumer surplus (4.36) yields

$$CS^{DB} = \frac{\Big(2(2+\beta)^2 + \beta^2t^2(1+\beta) - 2\beta t(1+\beta)(2+\beta)\Big)\Big(\omega + (1-\beta)k\Big)^2}{2(1-\beta)(4-(1+t)\beta^2)^2}.$$

When G acts in the dual mode and uses data exclusively, substituting the prices in (4.22) and (4.23) and the quantities in (4.30) and (4.31) into the consumer surplus (4.36) yields

$$\begin{aligned} CS^{DE} = & \frac{\Big(2(2+\beta)^2 - 2\beta t(2+\beta)(1+\beta) + t^2\beta^2(1+\beta)\Big)\omega^2}{2(1-\beta)(4-(1+t)\beta^2)^2} \\ & + \frac{2(1-\beta)\Big(2(2-t\beta)(1+\beta)+\beta^2\Big)\omega k + (1-\beta)(4-3\beta^2)k^2}{2(1-\beta)(4-(1+t)\beta^2)^2}. \end{aligned}$$

In the pure marketplace mode, it is immediate that consumer surplus is higher when G shares data with both sellers than with no seller, i.e., $CS^{PB} > CS^{PN}$ holds.

In the pure marketplace mode, the consumer surplus is higher when G shares data with both sellers compared to exclusive data sharing with seller 1 if $CS^{PB} - CS^{PE} > 0$. The inequality holds if

$$2(2+\beta)^2\omega + \Big(2(2+\beta)^2(1-\beta) - (4-3\beta^2)\Big)k > 0. \qquad (4.37)$$

Since $\omega > k$ and the term in front of ω is positive, it is sufficient to prove that $2(2+\beta)^2 + 2(2+\beta)^2(1-\beta) - (4-3\beta^2) > 0$ to show that (4.37) holds. Rewriting the expression in question yields $2(2+\beta)^2(2-\beta) - 2(2-\beta^2) + \beta^2 > 0$ which holds given our parameter specifications. Thus, (4.37) holds and, therefore, $CS^{PB} > CS^{PE}$ holds.

Consumer surplus is higher in the pure marketplace mode when G shares data with both sellers than in the dual mode with data sharing if $CS^{PB} - CS^{DB} > 0$. The inequality holds if

$$2(4+4\beta+\beta^2)(2-\beta) - t(4+4\beta-\beta^2)\beta > 0$$

since $2 > t$, $(4+4\beta+\beta^2) > (4+4\beta-\beta^2)$, and $(2-\beta) > \beta$. Thus, the inequality holds for our parameter specifications, hence, $CS^{PB} > CS^{DB}$ holds.

In the dual mode, consumer surplus is higher with data sharing compared to exclusive data usage if $CS^{DB} - CS^{DE} > 0$. The inequality holds if

$$\begin{aligned} & 2\Big((2+\beta)^2 - \beta t(1+\beta)(2+2\beta-t\beta)\Big)\omega \\ & + \bigg(4 - 3\beta^2 - 2\beta^3 - \beta t(1+\beta)(1-\beta)\Big(2(2+\beta) - \beta t\Big)\bigg)k > 0. \end{aligned} \qquad (4.38)$$

To show that the inequality holds, consider the first term of the inequality. Notice first that $(2+\beta) > (1+\beta)$. Second, we now show that $(2+\beta) > \beta t(2+2\beta-t\beta)$. The derivative of the RHS of the inequality in question w.r.t. t is $2\beta(1+\beta(1-t)) > 0$. Thus, inserting $t = 1/2$ into the condition yields the strictest condition. Inserting $t = 1/2$ in $(2+\beta) > \beta t(2+2\beta - t\beta)$ yields $8 - 3\beta^2 > 0$ which clearly holds. Thus, the first term of the inequality (4.38) is positive. Given that $\omega > k$ and that the term in front of ω is positive, it is sufficient to prove that $2((2+\beta)^2 - \beta t(1+\beta)(2+2\beta - t\beta)) + (4 - 3\beta^2 - 2\beta^3 - \beta t(1+\beta)(1-\beta)(2(2+\beta) - \beta t)) > 0$. Rewriting the expression in question yields

$$4 - \beta^2 - 2\beta^3 + 8(1+\beta)(1-t\beta) + t\beta^2(1+\beta)\Big(t(2+(1-\beta)) - 2(1-\beta)\Big) > 0,$$

which holds given our parameter specifications. Consequently, (4.38) holds. Hence, $CS^{DB} > CS^{DE}$ holds. Since $CS^{PB} > CS^{DB}$ and $CS^{DB} > CS^{DE}$ hold, then $CS^{PB} > CS^{DE}$ also holds. Combining the results above yields the ranking $CS^{PB} > \max(CS^{PE}, CS^{PN}, CS^{DB}, CS^{DE})$ and $CS^{DB} > CS^{DE}$. □

Proof of Lemma 4.6.
Whenever platform G acts as a pure marketplace and shares data with both sellers, substituting the equilibrium prices from (4.11) for p_1 and p_2 and $\delta_1 = 1$ and $\delta_2 = 1$ into the profit function of seller 2 in (4.3) yields

$$\pi_2^{PB} = \frac{(1-t)\Big(\omega + (1-\beta)k\Big)^2}{(2-\beta)^2}.$$

When G acts as a pure marketplace and shares data exclusively with seller 1, substituting the equilibrium prices from (4.12) for p_1 and (4.13) for p_2, and $\delta_1 = 1$ and $\delta_2 = 0$ into the profit function of seller 2 in (4.3) yields

$$\pi_2^{PE} = \frac{(1-t)\Big((2+\beta)\omega - \beta k\Big)^2}{(2+\beta)^2(2-\beta)^2}.$$

When G acts as a pure marketplace and does not share data with the sellers, substituting the equilibrium prices from (4.14) for p_1 and p_2, and $\delta_1 = 0$ and $\delta_2 = 0$ into the profit function of seller 2 in (4.3) yields

$$\pi_2^{PN} = \frac{(1-t)\omega^2}{(2-\beta)^2}.$$

When G operates in the dual mode and shares data with seller 2, substituting the equilibrium prices from (4.20) for p_G and (4.21) for p_2, and $\delta_2 = 1$ into the profit function of seller 2 in (4.10) yields

$$\pi_2^{DB} = \frac{(1-t)\Big((2+\beta)\omega + (2+\beta)(1-\beta)k\Big)^2}{\Big(4-(1+t)\beta^2\Big)^2}.$$

When G operates in the dual mode and uses data exclusively, substituting the equilibrium prices from (4.22) for p_G and (4.23) for p_2, and $\delta_2 = 0$ into the profit function of seller 2 in (4.10) yields

$$\pi_2^{DE} = \frac{(1-t)\Big((2+\beta)\omega - \beta k\Big)^2}{\Big(4-(1+t)\beta^2\Big)^2}.$$

In the pure marketplace mode, it is immediate that seller 2's profit is higher when G shares data with both sellers than with no seller, i.e., $\pi_2^{PB} > \pi_2^{PN}$ holds.

Seller 2's profit is higher when G acts in the dual mode than in the pure marketplace mode when G shares data with seller 2 if $\pi_2^{DB} - \pi_2^{PB} > 0$. The inequality holds if

$$8 - (2+t)\beta^2 > 0,$$

which is true for our parameter specifications. Hence, $\pi_2^{DB} > \pi_2^{PB}$ holds.

Seller 2's profit is higher when G acts in the dual mode and shares data with seller 2 than in the pure marketplace mode when G does not share data with seller 2 if $\pi_2^{DB} - \pi_2^{PE} > 0$. The inequality holds if

$$(2+\beta)\beta^2\omega t + (8 - 6\beta^2 + \beta^4)k - \beta^3 kt > 0,$$

which holds for our parameter specifications. Hence, $\pi_2^{DB} > \pi_2^{PE}$ holds.

In the dual mode, seller 2's profit is higher when G shares data with seller 2 than when G does not share data with seller 2 if $\pi_2^{DB} - \pi_2^{DE} > 0$. The inequality holds if

$$(2-\beta^2)k > 0,$$

which is true for our parameter specifications. Hence, $\pi_2^{DB} > \pi_2^{DE}$ holds.

In the pure marketplace mode, seller 2's profit is higher when G shares data with seller 2 than when G does not share data with seller 2 if $\pi_2^{PB} - \pi_2^{PE} > 0$. The inequality holds if

$$2(2+\beta)\omega + (2-\beta^2)k > 0,$$

which is true for our parameter specifications. Hence, $\pi_2^{PB} > \pi_2^{PE}$ holds. Since $\pi_2^{DB} > \pi_2^{PB}$ and $\pi_2^{PB} > \pi_2^{PE}$ hold, $\pi_2^{DB} > \pi_2^{PE}$ also holds. Combining the results above yields the ranking $\pi_2^{DB} > \max\left(\pi_2^{PB}, \pi_2^{PE}, \pi_2^{PN}, \pi_2^{DE}\right)$ and $\pi_2^{PB} > \pi_2^{PE}$. □

Proof of Lemma 4.7.

Welfare is the sum of consumer surplus and firms' profits. Whenever platform G acts as a pure marketplace and shares data with both sellers, welfare is

$$W^{PB} = \frac{(3-2\beta)\Big(\omega + (1-\beta)k\Big)^2}{(1-\beta)(2-\beta)^2}.$$

When G in the pure marketplace mode shares data with seller 1 exclusively, welfare is

$$W^{PE} = \frac{\Big(2(2+\beta)^2(3-2\beta)\omega + (1-\beta)k\Big)\omega + (12 - 9\beta^2 + 2\beta^4)(1-\beta)k^2}{2(1-\beta)(4-\beta^2)^2}.$$

When G in the pure marketplace mode does not share data with the sellers, welfare is

$$W^{PN} = \frac{(3-2\beta)\omega^2}{(1-\beta)(2-\beta)^2}.$$

When G acts in the dual mode and shares data with seller 2, welfare is

$$W^{DB} = \frac{\Big(2(2+\beta)^2(3-2\beta) - 2\beta t(2+\beta)(1+2\beta-\beta^2) - \beta^2 t^2(1+\beta)(1-2\beta)\Big)\Big(\omega + k(1-\beta)\Big)^2}{2(1-\beta)\Big(4-(1+t)\beta^2\Big)^2}.$$

When G in the dual mode uses data exclusively, welfare is

$$W^{DE} = \frac{\Big(2(2+\beta)^2(3-2\beta) - 2\beta t(2+\beta)(1+2\beta-\beta^2) - \beta^2 t^2(1+\beta)(1-2\beta)\Big)\omega^2}{2(1-\beta)\Big(4-(1+t)\beta^2\Big)^2}$$
$$+ \frac{2(1-\beta)\Big((2+\beta)^2(3-2\beta) - \beta t\Big((2+\beta)(2+3\beta-\beta^2) - 2(1+\beta)\Big) + \beta^3 t^2(1+\beta)\Big)\omega k}{2(1-\beta)\Big(4-(1+t)\beta^2\Big)^2}$$

$$+\frac{(1-\beta)\Big(2\big(3-\beta^2(1+t)\big)(2-\beta^2)+\beta^2\Big)k^2}{2(1-\beta)\big(4-(1+t)\beta^2\big)^2}.$$

In the pure marketplace mode, it is immediate that welfare is higher when G shares data with both sellers than with no seller, i.e., $W^{PB} > W^{PN}$ holds.

In the pure marketplace mode, the total welfare is higher when G shares data with both sellers compared to exclusive data sharing if $W^{PB} - W^{PE} > 0$. The inequality holds if

$$2(2+\beta)^2(3-2\beta)\omega + \Big(2(2+\beta)^2(3-2\beta)(1-\beta) - (12-9\beta^2+2\beta^4)\Big)k > 0. \quad (4.39)$$

The first term of the inequality (4.39) is positive while the second term can be negative. Given $\omega > k$, the inequality (4.39) holds if the positive effect on ω outweighs the potential negative effect on k. Therefore, if $2(2+\beta)^2(3-2\beta) + (2(2+\beta)^2(3-2\beta)(1-\beta) - (12-9\beta^2+2\beta^4)) > 0$. Rewriting the inequality in question gives $2(2+\beta)^2(3-2\beta)(2-\beta) + 9\beta^2 - 2(6+\beta^4) > 0$ which holds given our parameter specifications. Hence, $W^{PB} > W^{PE}$ holds.

Total welfare is higher in the pure marketplace mode when the G shares data with both sellers than in the dual mode with data sharing if $W^{PB} - W^{DB} > 0$. The inequality holds if

$$2(2+\beta)^2(2-\beta)(1-\beta) + \beta t\Big(4(1-\beta) + 2\beta^3 - \beta^2\Big) > 0. \quad (4.40)$$

It can be clearly seen that the first term is positive, whereas the sign of the second term is less straightforward. Therefore, to prove that the inequality (4.40) holds, it is sufficient to show that

$$4(1-\beta) + 2\beta^3 - \beta^2 > 0. \quad (4.41)$$

Differentiating (4.41) w.r.t. β yields

$$\frac{\partial LHS(4.41)}{\partial \beta} = -4 - 2\beta + 6\beta^3 < 0.$$

Hence, the condition (4.41) is strictest at $\beta \to 1$. The limit case $\beta \to 1$ yields $1 > 0$. Hence, (4.41) holds and, consequently, (4.40) holds. Thus, $W^{PB} > W^{DB}$ holds.

In the dual mode, total welfare is higher with data sharing compared to exclusive data usage if $W^{DB} - W^{DE} > 0$. The inequality holds if

$$\begin{aligned}&2\Big((2+\beta)^2(3-2\beta) - \beta t\Big((2-\beta^2)(1+2\beta) + \beta t(1-\beta^2)\Big)\Big)\omega \\ &+ \Big(2(2+\beta)\Big(2-5\beta+\beta^2(1+\beta)\Big) + (4-3\beta^2) + 2\beta^3 t(4-\beta^2) \\ &- \beta t(1+\beta)\Big(2(2-\beta) + \beta t(1-\beta)(1-2\beta)\Big)\Big)k > 0. \end{aligned} \tag{4.42}$$

The inequality in (4.42) consists of two terms. The first term is positive if $(2+\beta)^2(3-2\beta) > \beta t((2-\beta^2)(1+2\beta)+\beta t(1-\beta^2))$. The LHS of the expression is independent of t whereas the RHS clearly increases in t. Therefore, the condition is strictest at $t = 1/2$. Inserting $t = 1/2$ in the condition yields $19+29(1-\beta^2)+6\beta(2-\beta^2)+3\beta^4 > 0$, consequently, the first term of (4.42) is positive. Given $\omega > k$ and the term in front of ω is positive, it is sufficient to prove that $2(2+\beta)^2(3-2\beta) - \beta t((2-\beta^2)(1+2\beta)+\beta t(1-\beta^2))) + (2(2+\beta)(2-5\beta+\beta^2(1+\beta)) + (4-3\beta^2) + 2\beta^3 t(4-\beta^2) - \beta t(1+\beta)(2(2-\beta)+\beta t(1-\beta)(1-2\beta))) > 0$. Rearranging the inequality yields

$$\begin{aligned}&2(2-\beta)(2+\beta)(4-\beta-\beta^2) + (4-3\beta^2) \\ &- \beta t\Big(2(4+5\beta-6\beta^2-\beta^3+\beta^4) + \beta t(1-\beta^2)(3-2\beta)\Big) > 0.\end{aligned}$$

This inequality holds given our parameter specification and, consequently, (4.42) holds. Hence, $W^{DB} > W^{DE}$ holds. Since $W^{PB} > W^{DB}$ and $W^{DB} > W^{DE}$ hold, $W^{PB} > W^{DE}$ also holds. Combining the results above yields the ranking $W^{PB} > \max(W^{PE}, W^{PN}, W^{DB}, W^{DE})$ and $W^{DB} > W^{DE}$. □

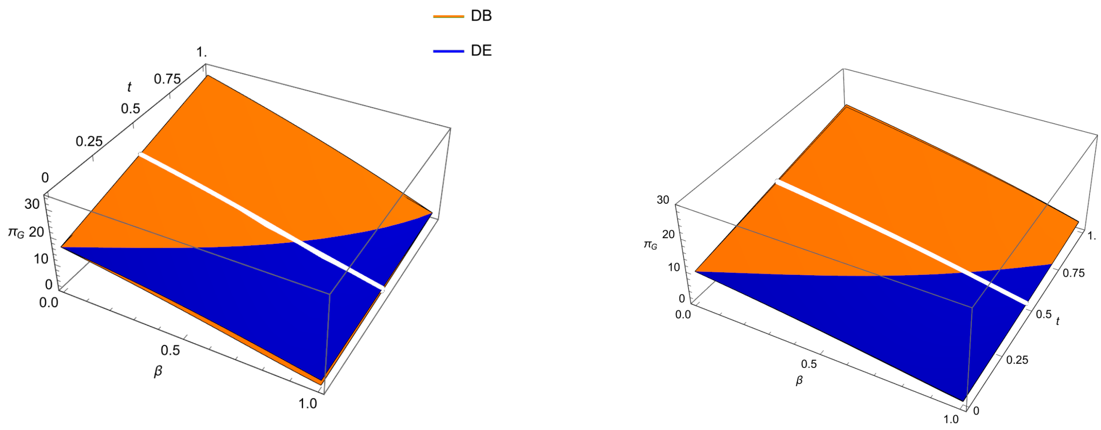
A4.2 Three Dimensional Plots of Platform Profits

In this part of the appendix, we present numerical simulations of the profits platform G obtains in the pure marketplace mode and dual mode under the different data-sharing regimes.

First, we consider numerical simulations for platform profits in dual mode under the two data-sharing regimes in Figure 4.4. We show the platform profits in the model parameters marketplace fee t and product substitutability β. The orange plane represent platform profits when G in the dual mode shares data with independent seller 2. The blue plane demonstrates platform profits when G uses data exclusively. The white line indicates a marketplace fee of 1/2. For all combinations of β and t where the orange plane overlaps the blue plane, platform profits are higher with data sharing. When the blue plane lies above the orange plane, platform profits are higher when using data exclusively.

In Figure 4.1 in the main text, we set $V = 5$ and $k = 1$. In this appendix, we show that our results do not change qualitatively when altering k. To this end, we V remains at 5, while we substitute different values for k. In Figure 4.4 (a) the product improvement, k, is set to $k = 2$ and, thereby, larger than in Figure 4.1. By comparing both figures, we see that an increase in the product improvement, k, leads to an increase of platform profits in both data sharing regimes. Also, we observe qualitatively the same pattern in the optimal data-sharing regime of the platform. In Figure 4.4 (b) the product improvement is set to $k = 1/4$ and thereby smaller than in Figure 4.1. In this setting, platform profits are lower in both data-sharing regimes. Again, we find that the pattern in the optimal data-sharing regime remains qualitatively.

Figure 4.4: Platform Profits in Dual Mode with Varying Product Improvement



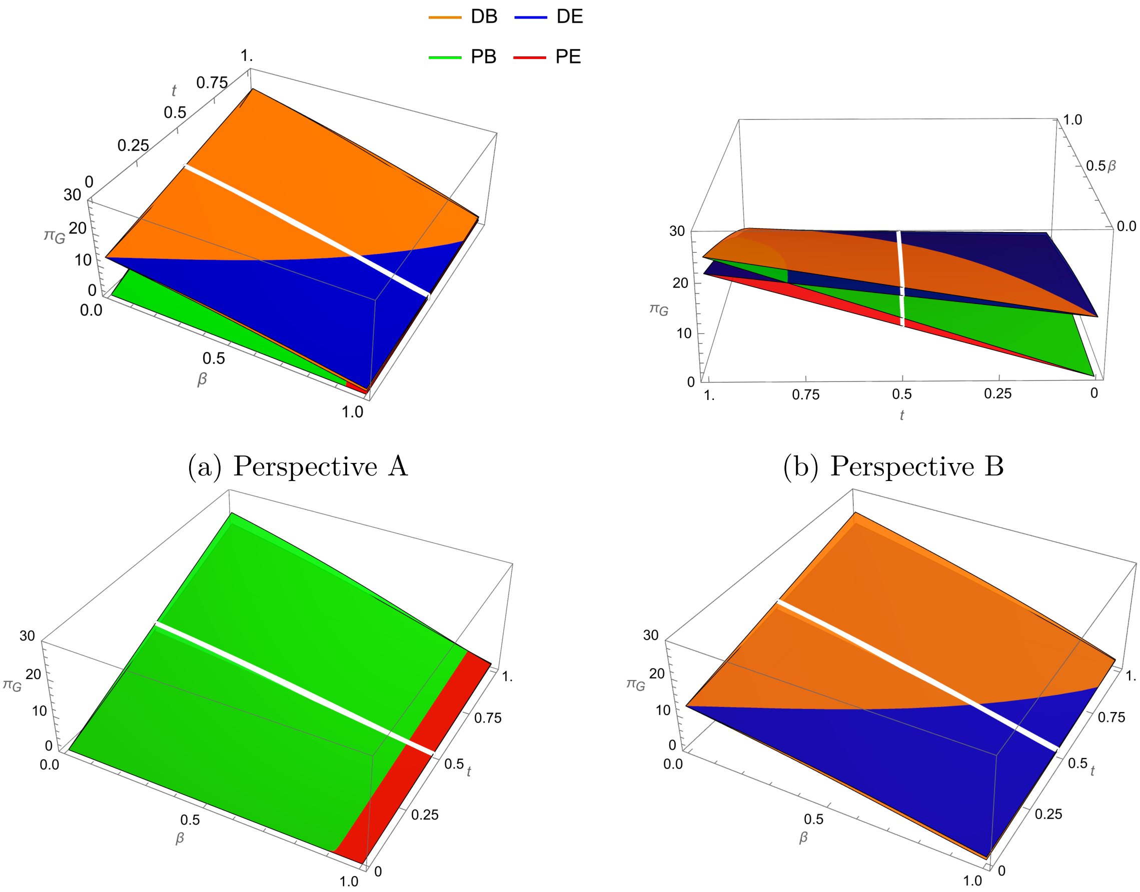
(a) $k = 2$ (b) $k = 1/4$

Platform profits in dual mode for different data-sharing regimes, where $V = 5$. The white line indicates $t = 1/2$. DB denotes the outcome where the platform in the dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively. PB denotes the outcome where the pure marketplace shares data with both sellers.

In Figure 4.5, we present the profits of the platform in the pure marketplace mode and dual mode under the different data-sharing regimes. As before, platform profits are shown in the model parameters marketplace fee t and product substitutability β, while we set $V = 5$ and $k = 1$. The orange plane represents platform profits in the dual mode with data sharing and the blue plane shows platform profits when G uses data exclusively. The green and the red planes display platform profits in the pure marketplace mode whenever G shares data with both sellers and with seller 1 exclusively. Figures 4.5 (a) and (b) depict G's profits in any situation from two different angles. We find that the orange and blue plane lie above the green and red ones. Therefore, in the numerical simulation, dual mode is preferred by the platform for $0 \leq t \leq 1$.

As t increases, the blue plane, representing π_G^{DE}, eventually lies below the green plane, which shows π_G^{PB}. This indicates that whenever t is high, there are cases where the platform prefers π_G^{PB} over π_G^{DE}. However, notice that the green plane remain below the orange plane which represents π_G^{DB}.

Figure 4.5: Three Dimensional Plots of Platform Profits



(a) Perspective A

(b) Perspective B

(c) Only pure marketplace mode

(d) Only dual mode

Platform profits in the pure marketplace mode and dual mode for different data-sharing regimes, where $V = 5$ and $k = 1$. The white line indicates $t = 1/2$. DB denotes the outcome where the platform in the dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively. PB denotes the outcome where the pure marketplace shares data with both sellers. PE denotes the outcome where the pure marketplace shares data one seller exclusively.

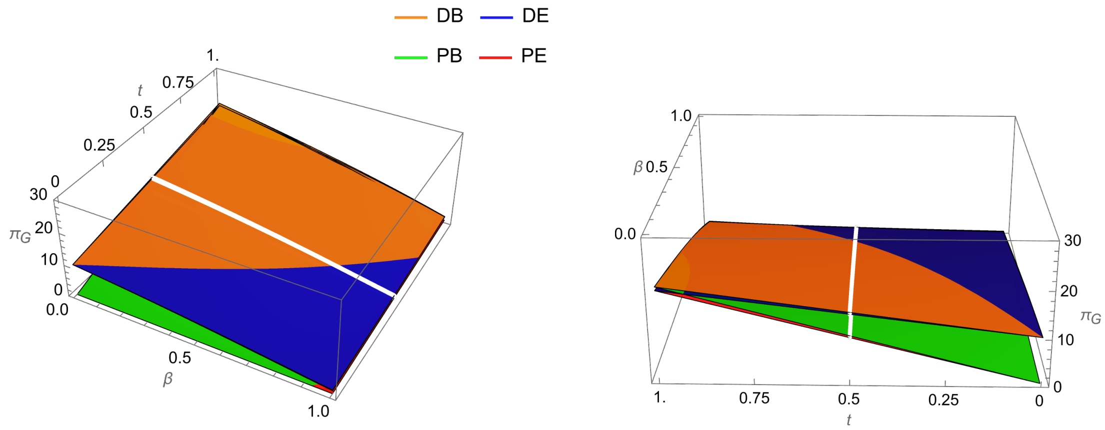
Figure 4.5 (c) depicts only the platform profits in the pure marketplace mode, whereas Figure 4.5 (c) shows only the dual mode profits under all data-sharing regimes and the same parametrization. Figure 4.5 (c) demonstrates that when β is sufficiently high, the platform in the pure marketplace mode prefers π_G^{PE} over π_G^{PB}, while t has no effect on the decision.[24] Figure 4.5 (d) shows the profits of the platform in the dual mode. We find that the platform in the dual mode uses data exclusively when products are close substitutes and the marketplace fee is sufficiently low. On the other hand, the platform shares data with the independent seller when

[24]As explained in the main text, whenever G opts for the pure marketplace mode, the prices set by the independent sellers are independent of t.

products are less substitutable or the marketplace fee is sufficiently high.

Figure 4.5 demonstrates platform profits when the data-driven product improvement k equals 1. In contrast, below in Figure 4.6, we present the same plots as in Figure 4.5 (a) and (b), however, setting $k = 1/4$. Comparing these Figures to 4.5 (c) and (d), we find that our results remain qualitatively the same, even if $1/2 < t \leq 1$.

Figure 4.6: Platform Profits in the Pure Marketplace and Dual Mode for $k = 1/4$



(a) Perspective A (b) Perspective B

Platform profits in the pure marketplace mode and dual mode for different data-sharing regimes, where $V = 5$ and $k = 1/4$. The white line indicates $t = 1/2$. DB denotes the outcome where the platform in the dual mode shares data with the independent seller. DE denotes the outcome where the platform in the dual mode uses data exclusively. PB denotes the outcome where the pure marketplace shares data with both sellers. PE denotes the outcome where the pure marketplace shares data one seller exclusively.

The simulations suggest that our results on the optimal operating mode hold qualitatively for $1/2 < t \leq 1$. However, for traceability reasons, we restricted our analysis to $0 \leq t \leq 1/2$ when analyzing the optimal operating mode of the platform.

5 Epilogue

This dissertation examines the industrial organization of platform markets. Each of the three chapters contributes to a better understanding of a specific mechanism that shapes those markets. The characteristics are modeled in a stylized form, and the strategic interactions are derived and explained through game-theoretical modeling. From these analyses, insights are generated with relevance for platforms, users, and policymakers.

Each chapter considers a different stage in the evolution of a platform market. Chapter 2 analyzes the coordination problem that arises in the launch phase of a platform. Subsequently, an information strategy is derived that can increase the probability of a successful establishment of the platform in the market. The following two chapters examine highly concentrated markets where platforms have already established. Due to platforms' decisive role in the market, they can make strategic decisions that influence the set of action available to sellers. In Chapter 3, platforms can induce sellers to offer their products exclusively on their platform. In Chapter 4, a platform decides whether sellers have access to data that enables sellers to better adapt their products to customer preferences. In both approaches, platforms shape sellers' scope for action, which in turn influences the consumer side as well.

Chapters 3 and 4 of this dissertation address the prevailing debate surrounding the antitrust concerns regarding digital platforms. This debate shapes a large part of ongoing research in industrial organization and is particularly relevant for policymakers, who are currently deeply engaged in implementing and enforcing regulations aimed to ensure fair and contestable competition in digital markets. Technological progress is advancing at a remarkable pace, such that researchers and regulatory authorities can barely keep pace with technological advancement and its implications for antitrust issues in their analyses. A current challenge for researchers and policymakers is to understand the role of data in digital markets. The volume and processing of data is already a decisive competitive advantage today and shapes digital markets and the competitive dynamics. Consequently, data access will become an even more critical determinant of market power over time. This poses a major challenge for policymakers to ensure that sufficient competition takes place.

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