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Mandated Data-sharing in Hybrid Marketplaces

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Abstract

We study a hybrid marketplace where a vertically integrated platform competes with a seller in a horizontally differentiated downstream market. The platform has a data advantage and can price discriminate consumers, whereas the seller cannot. Our analysis shows that, by properly setting the per-unit transaction fee, the platform can always avoid head-to-head competition with the seller, regardless of the level of horizontal differentiation. Mandating data-sharing, which allows the seller to also price discriminate, does not seem to solve this problem and, in fact, aggravates it further, generally benefiting the platform. The seller is better off only if it is less efficient than the platform, whereas consumers are worse off. We propose that preventing the platform from adjusting the fee after the data-sharing mandate is not enough to reinstate competition in the downstream market. We then show that banning the hybrid business model and forbidding the use of data for price discrimination increase consumer surplus, even if the seller becomes a monopolist. In other words, we propose that the harm to competition comes from the platform's business model rather than from its information advantage.

Keywords: *hybrid platforms, data-sharing, vertical integration, price discrimination.*
JEL codes: *D42, L12, L41.*

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1 Introduction

Access to relevant consumer information is a commercial asset that grants firms substantial competitive advantage in the market. In the last decades, the advancement of information and communication technology, specifically digital technology, has accelerated the ability of companies to accurately profile their demand. Cookies and related tracking instruments monitor and record users' browsing histories and, building on those, permit firms to infer their customers' preferences and tastes (Miklós-Thal et al., 2024). Therefore, it comes as no surprise that the market for data has grown to a considerable size in the last decades. Indeed, the European Commission estimated that "the value of the data market, defined as the marketplace where digital data are exchanged as "products" or "services", reached €82 billion in 2023, with an increase of 11.1% on the previous year from approximately €74 billion in 2022" (European Data Market Study 2021-2023, EDMS hereafter, pg. 11).[1] From 2013, the first year of the European Data Market Study, the value has increased by 75% from approximately €47 billion, and, in the most conservative scenario, it is expected to reach a value of €104 billion by 2030 (EDMS, pp. 13–14).

To maintain their competitive edge, firms increasingly depend on timely access to relevant consumer information and their ability to use data to develop new applications, services, and products. However, the dominance of digital platforms has resulted in unequal access to user data, granting them a substantial advantage over other market players. For these reasons, a widespread debate has emerged on whether – and under which conditions and legal bases – public intervention is required to ensure adequate access to data. One of the proposed remedies is to mandate digital companies to share with complementors and rivals all or part of the consumers' data they contribute to generating. Data-sharing is indeed one of the pillars of the European strategy for data.[2] Moreover, it is central in the *Regulation on harmonised rules on fair access and use of data* (Data Act, hereafter). The new regulation, in force since January 11, 2024, aims to "facilitate access to data for [start-ups, small enterprises, and medium-sized enterprises], while ensuring that the corresponding obligations are as proportionate as possible to avoid overreach" (Data Act, Recital 40, pg. 13).[3]

Even more relevantly, data-sharing is at the core of the Digital Markets Act, the recently introduced EU regulatory tool that mandates obligations and a code of conduct for large digital platforms.[4]

This paper analyses how data and data-sharing influence the strategic interactions between a hybrid platform and the sellers operating within the digital marketplace. We investigate the effects of mandated data-sharing on market outcomes and social welfare when data represents

[1] Available at: https://digital-strategy.ec.europa.eu/en/library/results-european-data-market-study-2021-2023. Last access on May 17, 2024.

[2] Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN. Last access on May 17, 2024.

[3] Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302854&qid=1714118919465. Last access on May 17, 2024.

[4] In particular, see Art. 6(9) and Art. 6(10) of the Digital Markets Act. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R1925&from=EN. Last access on May 17, 2024.

information about users' preferences and can be used to price discriminate them. We focus on a setting where a digital platform is vertically integrated with one of the two competing sellers in the market. The independent seller must pay the platform a per-unit transaction fee for operating in the marketplace, whereas consumers do not pay any admission fee. We focus on the case where the consumers' valuations of the platform's and the seller's products are negatively correlated, modeling the market as a Hotelling line. Indeed, hybrid platforms have been observed entering their markets with "copycat" products — i.e., products that are extremely similar to those already present in the market and thus in direct competition with them (Kirpalani and Philippon, 2020).

Importantly, in our setting, the platform makes two decisions: first, it sets the size of the per-unit transaction fee; second, it quotes a price to compete against the independent seller in the market for the final good. This setup is consistent with a large family of digital hosting platforms that decide to operate as first-party sellers and compete with their suppliers. Amazon Marketplace is an obvious reference for our analysis, but it is not the only one; Walmart.com and AliExpress, among others, also fit the description of the model.

We solve the model considering two scenarios. In the baseline, we assume the vertically integrated platform possesses a data advantage, meaning that it alone knows the exact location of consumers on the Hotelling line and can use that information to offer personalized prices. The independent seller, in this scenario, is uninformed and can only post a uniform price. Then, we impose a mandated data-sharing regime that removes the platform's information advantage. In this scenario, both the platform and the independent seller know the exact location of consumers and engage in price discrimination. The comparison of the results in the two regimes yields our two main findings.

Our first result pertains to the equilibrium market configurations that occur in this environment, depending on the intensity of competition between the two products. When competition is intense, either the platform or the seller obtains the whole market, depending on who is more efficient — i.e., on their marginal costs. Importantly, if the seller is more efficient than the platform, the latter effectively gives up the hybrid business model and acts as a simple intermediary. When the degree of horizontal differentiation between the two products is high, and, therefore, competition is not intense, both the seller and the platform act as monopolists and partially uncover the market. Instead, for intermediate values of horizontal differentiation, the platform strategically decides whether to compete for some consumers it could profitably serve or to leave them to the independent seller. It does so by comparing the tailored prices that it must offer to serve those consumers and the associated opportunity cost, measured by the transaction fee that the platform is giving up. In this case, the platform coordinates with the seller and segments the market to ensure full extraction of the consumer surplus. We find that data-sharing makes this last scenario more likely to occur.

Relatedly, our second finding pertains to the welfare effect of price discrimination in a platform environment. We show that the pro-competitive push found in the literature (Thisse and Vives, 1988; Rhodes and Zhou, 2024) does not materialize in a setting where one of the firms owns the marketplace. In fact, the presence of a transaction fee generates an opportunity cost for the platform that limits the extent to which it is willing to engage in price competition. We find that data-sharing in a hybrid marketplace environment causes even more surplus extraction than asymmetric use of data by the integrated company, with users being worse off. Under some conditions, also efficient sellers could be worse off, as the contribution of data to the competitive advantage of such firms is limited, whereas the negative effect from the adjustment of the transaction fee is substantial.

Building on these findings, we analyze the effects of two complementary remedies to temper the unintended consequences of mandatory data-sharing and re-establish efficiency. First, we test a mandate that forbids the platform from adjusting the fee after the mandatory data-sharing provision. While this remedy effectively reduces the damages to sellers, we find that it is not sufficient to induce direct competition between the platform and the seller, thus yielding no effects on consumers. Second, we instead consider a more radical (and somehow provocative) remedy that bans both the hybrid business model and data-sharing. Even though this results in the seller being a downstream monopolist, our analysis shows that consumers are better off. This result stems from the seller's inability to target individual consumers, which results in a higher consumer surplus. The remainder of the paper is organized as follows. Section 2 presents a review of the relevant literature. Section 3 describes the model setup. Section 4 presents the results under no data-sharing, whereas Section 5 shows the results under data-sharing. Section 6 analyzes the effects of possible additional remedies. Finally, Section 7 concludes.

2 Literature review

The extraordinary attention on the potential effects of data gathering and analytics on competition is underscored by the extensive literature that the topic has inspired.[5] In their seminal paper, Thisse and Vives (1988) advance the argument that, if information is symmetrically accessible to all firms in the market, the price-discrimination practice that ensues has pro-competitive effects, as each consumer effectively becomes a market. From a theoretical perspective, the literature has confirmed this result and illustrated how the commercial value of consumer data is maximized when its access is asymmetric, because of exclusive deals or partitioned information (Montes et al., 2019; De Corniere and Taylor, 2020; Bounie et al., 2021; Abrardi et al., 2024).

More recently, Rhodes and Zhou (2024) excellently show that the welfare effect of price discrimination depends on the characteristics of the market: consumers benefit from it when market coverage is high, whereas they are worse off in case of low market coverage (the opposite for firms). Consistently with the literature, they find that asymmetric access to data damages consumers compared to when either all or no firms offer tailored prices.[6]

Building on these results, the literature has started investigating the incentives of the firms to

[5]For a detailed survey of the literature and a comparison of some of the most recent models of competition with consumer data, see Goldfarb and Tucker (2019), Bergemann and Bonatti (2019), and Pino (2022).

[6]Similarly, Belleflamme et al. (2020) and Gu et al. (2019) analyze the effects of exclusive access to data on market structure and competition. Both find that, in such settings, firms are able to soften price competition and raise prices above marginal costs.

use the data they possess strategically — i.e., by purposely selecting which information to use to offer tailored prices to consumers. In particular, Choe et al. (2024) show how an informed seller is better off by partitioning the market and optimally disclosing to the rival information about a specific group of consumers. This practice, the authors prove, softens market competition and maximizes the originally informed firm's profits. Our paper shows a similar feature in a very different setting. Where in Choe et al. (2024) firms are competing on the same level, we model a vertically integrated platform competing against a complementor. In other words, we analyze the incentives of a platform that profits from both intermediating an independent seller with the marketplace users as well as from directly selling a competing good in the market. The platform, under both exclusive access to data and full data-sharing, designs the market in such a way that there is always full extraction of consumer surplus. We argue that this happens because the platform's opportunity cost of serving a consumer is zero only if the seller finds serving that consumer unprofitable. Otherwise, the platform's opportunity cost equals the fee it would get had the competing seller made the sale. If the tailored price necessary to serve the consumer is lower than the transaction fee, the platform simply leaves the consumer to the seller and restrains itself from competing.

Parallel to the literature on data-driven price discrimination, privacy and consumers' control over the data they share took the main stage in the analysis of competition policy (Chen and Iyer, 2002; Casadesus-Masanell and Hervas-Drane, 2015; Choi et al., 2019; Xu and Dukes, 2022). In a recent article, Ali et al. (2023) illustrates conditions for consumers to benefit from sharing part of their data with selected firms. The issue of control is of paramount importance here. Consumers, by revealing incomplete information about their tastes and preferences, can induce price competition in a segment of the market where the local firm benefits substantial market power — hence, the pro-competitive effects. Despite not dealing with the important theme of privacy control, our model shows that full data-sharing with a vertically integrated platform seems to always harm consumers, because of the platform's ability to coordinate the market in order to ensure full surplus extraction. Somehow paradoxically, we show that, in our setting, consumers would be better off in a market covered by a monopolistic, uninformed seller than in one covered by two informed competitors.

In this article, we analyze the effect of the mandated disclosure of valuable data by an informed firm. Namely, we analyze the market interactions between a data-rich vertically integrated platform and an ex-ante uninformed seller. Information sharing has been extensively studied in the literature (Raith, 1996; Krämer and Schnurr, 2022; Prüfer and Schottmüller, 2021; Krämer and Shekhar, 2022). In a setting that is related to ours — i.e., a retail platform that hosts sellers — Liu et al. (2021) show that the platform has the incentive to disclose information only to a subgroup of sellers.[7] Relatedly, Magnani and Navarra (2023) show that a monopolistic hybrid platform has the incentives to share its superior market information with a rival third-party seller to relax price competition. While our work focuses on an exogenous intervention that mandates complete information sharing and does not explicitly allow the plat-

[7]This result is reminiscent of the well-established incentives of an innovator to license a superior technology to a subset of active firms. See Gallini and Wright (1990), Creane et al. (2013), and Sandrini (2023, 2024).

form to control this potentially strategic variable, we show that it would have the incentive to do so provided that it can manipulate the commission fee, effectively turning the transaction into a sale of data. If the platform is not allowed to modify its commission fee, complete data-sharing reduces its payoff without benefiting the consumers.

In modeling a vertically integrated platform, we adopt a setting that is reminiscent of the standard setup used in the literature on access to infrastructure in the presence of a vertically integrated monopolist (Economides, 1998; Beard et al., 2001). In particular, a paper that is close to ours in terms of both methodology and results is the recent work by Jullien et al. (2023). There, the authors analyze the optimal strategy of a manufacturer facing the problem of choosing the distributional channel to sell its final good. In detail, the product can be sold directly and exclusively by the manufacturer, or it can be jointly distributed together with an independent retailer. Moreover, they distinguish between three main scenarios, namely, when neither, either, or both firms can price discriminate consumers. With this setting, they find that dual-mode distribution is optimal if the manufacturer and the retailer's distribution services are negatively correlated, thus highlighting how *intra-brand* competition can be tempered by price discrimination (in contrast to the seminal results on *inter-brand* competition as in Thisse and Vives, 1988). Our results expand those of Jullien et al. (2023) in several directions.

First, we focus on *inter-brand* competition, where firms are differentiated in their marginal cost of production. Our results show that if data-sharing is mandated, consumers are always worse off as the platform can effectively avoid competition with the seller. Second, we propose a general approach that encompasses competition both in homogeneous and heterogeneous goods and that allows either the seller or the platform to serve the whole market if they are particularly more cost-efficient. Our analysis shows that several market configurations can arise depending on the level of horizontal differentiation, and the platform adjusts its strategy accordingly to effectively avoid competition with the seller. In more detail, if the seller is more cost-efficient and the degree of horizontal differentiation is low — i.e., competition is intense — the platform prefers remaining inactive in the market, *de facto* giving up the hybrid (dual) model. Third, we explore several complementary remedies that could be implemented in conjunction with the data-sharing mandate to test if and how consumers can benefit from such a policy.

In our analysis, we explore how hybrid platforms, which both compete and cooperate with their sellers, impact market outcomes (Dryden et al., 2020; Anderson and Bedre-Defolie, 2021; Etro, 2021, 2023; Shopova, 2023). Recent studies indicate that, although hybrid models are prevalent in successful markets, they can negatively affect seller growth and prompt price increases (Zhu and Liu, 2018). Sellers also tend to divert their innovation efforts away from markets entered by these platforms (Wen and Zhu, 2019). However, Foerderer et al. (2018) show that focusing on complementary goods can lead firms to invest in innovation due to increased demand. Our findings highlight that competing against hybrid platforms can reduce sellers' earnings, and that data-sharing doesn't always offset this disadvantage. In fact, policies favoring data-sharing might increase costs for efficient sellers without improving their competitive position.

3 Model set up

Consider a digital marketplace owned by a platform. In the market, a seller (s, it) and the platform (p, he/him) compete in prices for horizontally differentiated goods. The seller and the platform are located at the beginning and at the end of the $[0-1]$ Hotelling line, respectively. In what follows, we will sometimes refer to the seller and the platform together as to *firms*. We assume that in the market there is a continuum of consumers (she/her) uniformly distributed on the $[0-1]$ Hotelling line. They consume at most one unit of either the good sold by the seller or the one sold by the platform. A consumer located in $x \in [0,1]$ derives constant utility $u > 1$ from consuming either of the two goods and pays a price p_k, where $k = s, p$. Also, she suffers a mismatch disutility $t|z_k - x|$ from consuming a variety that is not her favorite one, where $t > 0$ is the transportation cost, and z_k is the location of the variety consumed ($z_s = 0$ and $z_p = 1$). The consumers' utility functions are:

$$\begin{aligned} U_s &= u - p_s - t\,x \\ U_p &= u - p_p - t(1-x) \\ U_{no} &= 0 \end{aligned}$$

where the subscript $_{no}$ stands for *no consumption*.

The seller and the platform compete in prices and sell two varieties of one good. We assume production does not involve any fixed cost, but the seller produces at a marginal cost $c_s \in [0,1]$. Instead, the platform produces at a marginal cost $c_p \in [0,1]$.

In addition to the marginal costs of production, the seller pays a per-transaction fee $f > 0$ to the platform to sell on the marketplace. Consequently, the payoffs of the two firms are:

$$\pi_s = D_s(p_s - c_s - f), \qquad \pi_p = D_p(p_p - c_p) + D_s\,f$$

where D_k indicates the demand of each firm $k = s, p$ and includes all consumers who derive larger utility from consuming the good produced by k than by $-k$ or than not consuming at all. Notice that the platform also earns revenues from per-transaction fees paid by the seller.

Intuitively, the seller must earn net revenues to stay active. It must set a price that is at least as high as the marginal costs of production, which are determined by the cost parameter c_s and, crucially, by the fee f set by the platform. By adjusting f, the platform can alter the price of the seller and the market demands, which are determined by the locations of the indifferent consumers.

Finally, we assume that the platform has data regarding all consumers in the market, which allows it to operate first-degree price discrimination. In other words, the platform sets a price $p_p^T(x)$, that is only offered to consumers located in x, whereas the seller sets a price p_s that is common for all consumers. Once data-sharing occurs, we also allow the seller to set tailored prices $p_s^T(x)$ for all consumers.

The timing of the game is the following: in Stage 0 the policy maker introduces a data-sharing policy. If there is no data-sharing, the platform uses data exclusively. Otherwise, the seller can also use data. In Stage 1, the platform sets the per-transaction fee f. In Stage 2, given the fee f, sellers and the platform set prices simultaneously. As data allow the data owners to price discriminate consumers based on their exact locations on the Hotelling line, we model price competition as in Montes et al. (2019), and Bounie et al. (2021), among others.[8] Finally, in Stage 3, consumers observe the prices and decide if and what they consume.[9] The solution concept is Subgame Perfect Nash Equilibrium, and the game is solved by backward induction.

4 Equilibrium without data-sharing

We start our analysis with the benchmark case where only the platform can access data and, in turn, price discriminate consumers.

4.1 Market configurations

As we do not pose limitations on t, apart from it being positive, the downstream market can be either fully or partially covered. In particular, it is useful to define the location of the consumer who is indifferent between buying from the seller or the platform, $\hat{x}_{s,p}$, as well as the location of the consumers who are indifferent between buying from the platform/seller and not buying at all, $\hat{x}_{p,no}$ and $\hat{x}_{s,no}$.

First, suppose $\hat{x}_{s,no} > \hat{x}_{p,no}$. Then, in equilibrium, the market is fully covered. Indeed, consumers located in $[\hat{x}_{p,no}, \hat{x}_{s,no}]$ could buy from either firm, whereas consumers in $[0, \hat{x}_{p,no}]$ buy from the seller and consumers in $[\hat{x}_{s,no}, 1]$ buy from the platform. This is the standard Hotelling duopoly (hd) case with full market coverage. Firms compete in the product market and prices are strategic complements.

Second, suppose instead that $\hat{x}_{s,no} < \hat{x}_{p,no}$. Then, consumers located in $(\hat{x}_{p,no}, \hat{x}_{s,no})$ cannot buy from either firm, and the market is only partially covered as some consumers are not served in equilibrium. This is the local monopolies scenario (lm), in which firms do not compete against each other and prices are not set strategically.

Finally, the locations of the consumer indifferent between buying from the seller and not buying at all are such that $\widehat{x}_{s,no} = \widehat{x}_{p,no} = \widehat{x}_{s,p}$. In other words, there exists a range of values of u such that the platform and the seller can achieve higher profits by pricing like monopolists, while the market is fully covered. This scenario is referred in the literature as *monopolistic duopoly* (md) case (Thépot, 2007; Bacchiega et al., 2023).[10] Prices are strategic substitutes

[8] When the platform holds information about consumers' location, but the seller does not, a well-known problem is the existence of a pure strategy Bertrand-Nash equilibrium (see Rhodes and Zhou, 2024). To ensure equilibrium existence, we assume that personalized price schedules are set only after uniform prices are set. Consistently, Amazon allegedly shows higher prices to Amazon Prime subscribers but compensates them with discounted services such as free shipping. See https://www.consumeraffairs.com/news/lawsuit-alleges-amazon-charges-prime-members-for-free-shipping-031414.html. Last access on May 17, 2024.

[9] Consistently with the literature, we assume consumers do not observe more than one price per firm. In other words, if a consumer observes personalized price by a firm, she cannot compare it with a uniform price by the same firm.

[10] The scenario has also been briefly analyzed in Choe et al. (2022), where it is referred to as *corner monopoly*.

and firms adjust them strategically to ensure the market is just covered. Differently from the Hotelling duopoly market configuration, the indifferent consumer derives zero utility from consuming either goods.

The generality of our model also introduces an additional strategic choice for the seller. Indeed, in a classic Hotelling setting, a seller would always set its equilibrium price so that the marginal consumer is indifferent between buying from it or the rival. Instead, under the local monopolies scenario, the seller would set the equilibrium price such that the marginal consumer is indifferent between buying from it or not buying at all. Such a strategic choice is absent for the platform, as he always offers tailored prices to individual consumers after observing the seller's basic price.

To obtain the seller's equilibrium pricing strategy with respect to the level of horizontal differentiation, we solve the game under the two pricing strategies and find the preferred one. The following lemma summarizes the results.

Lemma 1. *There exists a threshold $\bar{t}$, decreasing in f, such that if $t < \bar{t}$, the seller follows a competitive pricing strategy. Else, the seller follows a monopolistic pricing strategy.*

Proof. See the See Appendix. □

The results expressed in the Lemma derive from the fact that, if t is low, the platform can potentially serve a large share of consumers in the market. In such cases, opting for a monopolistic pricing strategy is not optimal for the seller, as the platform would poach most of its potential market share by undercutting the monopolistic price. The seller thus opts to price competitively to protect its turf and maximize its profits.

As t increases, both the platform and the seller's ability to profitably target distant consumers decreases. Thus, both the platform's competitive pressure on the seller and the profits the seller can extract from the marginal consumer decrease. Then, for $t \geq \bar{t}$, the seller opts for a monopolistic pricing strategy. Although such a strategy reduces the seller's market share, it increases the profits it makes on the individual consumers, as the platform cannot contest consumers who are located too close to the seller.

Intuitively, an increase in f widens the region t in which the seller prefers the monopolistic pricing strategy.[11] Indeed, an increase in f reduces the profits a seller makes on individual consumers, lowering the incentive to protect its market share.

Having analyzed the seller's pricing strategies, we now focus on the conditions under which the different market configurations can arise. The following lemma summarizes such conditions, and the respective seller's pricing strategy.

Lemma 2. *If $t \leq \frac{1}{3}(4u - 4f - 3c_p - c_s)$, the market is fully covered (hd), and the seller prices competitively. If $t > \frac{1}{2}(3u - f - 2c_p - c_s)$, the market is partially covered (lm) and the seller sets monopolistic prices. Else, monopolistic duopoly (md) ensues, and the seller prices competitively if $t < \bar{t}$ and as a monopolist otherwise.*

[11] Formally, we have that $\frac{\delta \bar{t}}{\delta f} < 0$ if $f < u - c_s$. However, for $f \geq u - c_s$, the seller would not be able to profitably serve any consumer regardless of her location and would thus not be active.

Proof. See the Appendix. □

Figure 1 gives a visual representation of the ranges of f and t for which the market configurations arise.

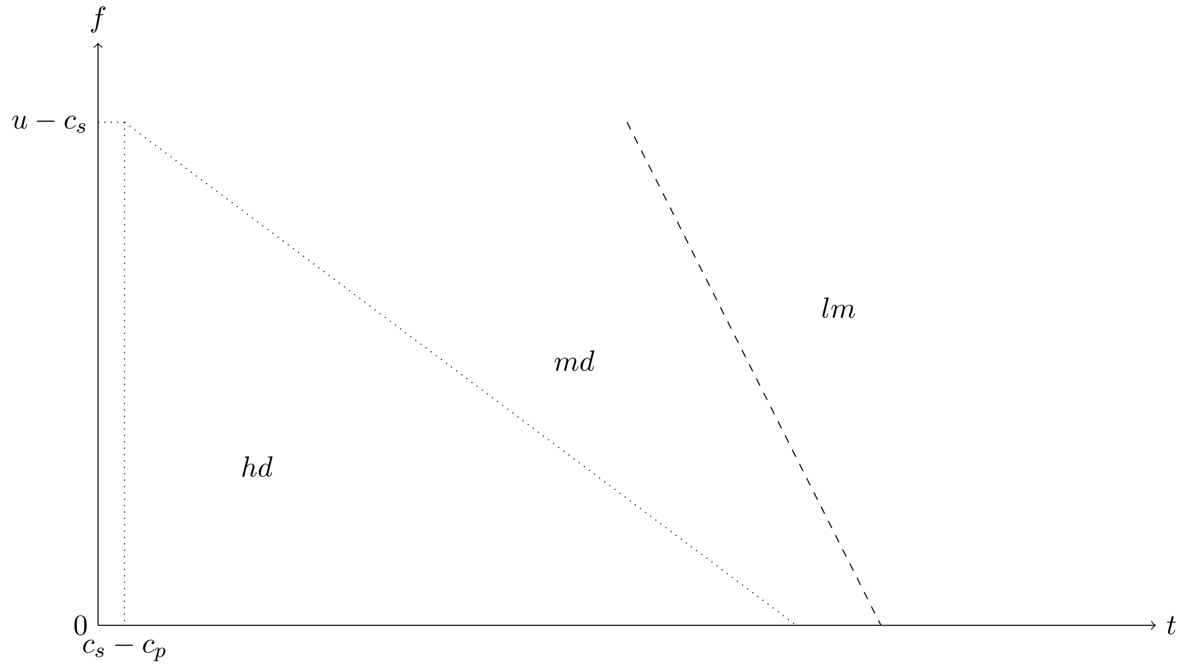

Figure 1: Market configurations as a function of t and f. $u = 10, c_p = 0, c_s = 0.5$. Hotelling duopoly ($hd$) emerges under the dotted black line, local monopolies (lm) emerge above the dashed black line and monopolistic duopoly (md) emerges between the two lines. Below $c_s - c_p$ the platform serves the whole market and above $u - c_s$ the platform serves the whole market.

Intuitively, when both t and f are low, both the seller and the platform can serve a large share of consumers, leading to full market coverage. The threshold in t is decreasing in f, as an increase in the per-transaction fee reduces the ability of the seller to serve distant consumers. Moreover, if $t \leq c_s - c_p$, then the platform serves the whole market by himself, granting full market coverage regardless of f.[12] Instead, if $f \geq u - c_s$, the seller cannot make profits in the market and is thus inactive, making the platform a monopolist. An increase in either t or f reduces the reach of firms, making the seller change its pricing strategy. Our analysis shows that there exists a region of parameters where the seller sets monopolistic prices and the platform covers the rest of the market, leading to monopolistic duopoly. Finally, for high values of either t or f, the platform is not able to profitably reach distant consumers and local monopolies ensue.

[12] In the Appendix, we show that if instead $c_p > c_s$, then the seller can serve the whole market by itself if $t \leq \frac{c_p - c_s}{3}$.

4.2 Equilibrium

Having presented the possible market configurations, we now focus on the platform's equilibrium strategy, as he maximizes his profits with respect to f. The following proposition summarizes the results.

Proposition 1. *In equilibrium, the platform never competes directly against the seller (i.e. hd never occurs). If $c_p \leq c_s$, for $t \leq c_s - c_p$, the platform sets $f^* \geq \frac{1}{2}(2u - c_p - c_s - t)$ and serves the whole market. Instead, if $c_p > c_s$, for $t \leq \frac{c_p - c_s}{4}$, the platform sets $f^* = u - c_s - 2t$ and the seller serves the whole market.*

Above these thresholds, for $t \leq \frac{1}{4}(5u - 4c_p - c_s)$, the platform sets $f^* = \frac{1}{5}(5u - 2c_p - 3c_s - 2t)$ and splits the market with the seller (md), whereas for $t > \frac{1}{4}(5u - c_s - 4c_p)$, the platform sets $f^* = \frac{1}{2}(u - c_s)$ and the market is partially covered (lm).

Proof. See the Appendix. □

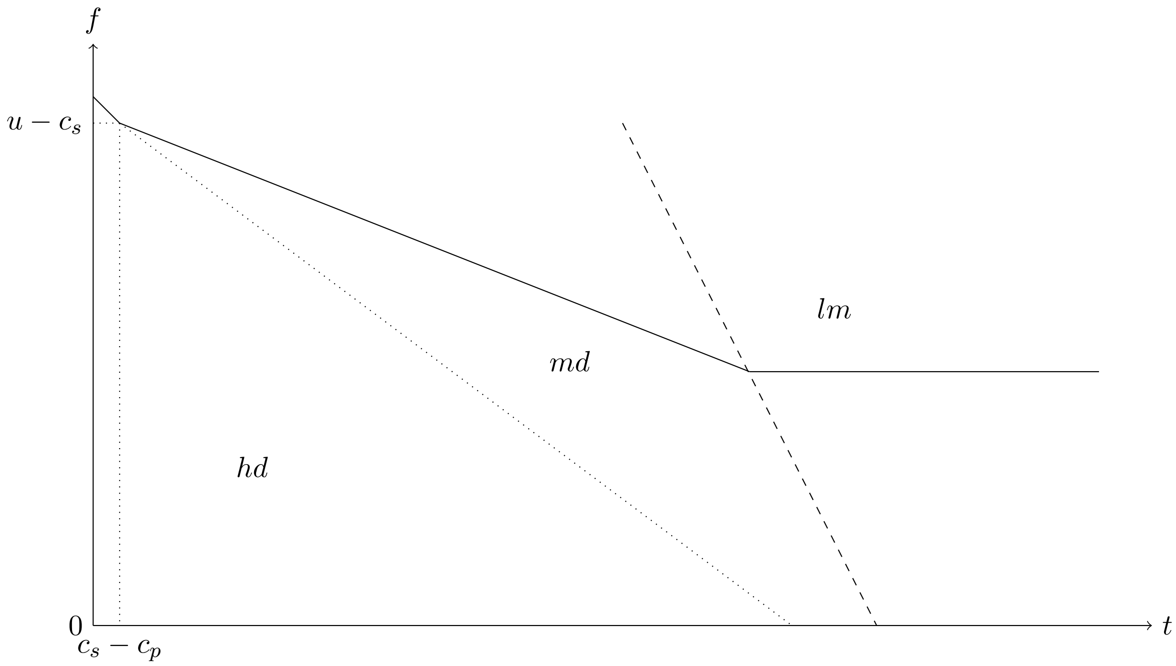

Figure 2: Equilibrium fee (solid black line) as a function of t. $u = 10, c_p = 0, c_s = 0.5$. In equilibrium, only monopolistic duopoly (md) and local monopolies (lm) emerge as equilibrium configurations. For $t \leq c_s - c_p$, the platform serves the whole market.

Proposition 1 highlights how the platform's strategy changes depending on the relative weight of the transportation cost with respect to the marginal costs. Figure 2 provides a visual representation of the equilibrium fee in the case where $c_p < c_s$. When t is low, both the seller and the platform can potentially serve the whole market. Then, if the platform is more cost-efficient he prefers to set a fee so high that the seller remains inactive, so that he serves all consumers (first segment of the solid black line in Figure 2). Conversely, if the seller is more cost-efficient, the platform would not be able to serve consumers even when entering the market, and thus only obtains profits through the fee.

Instead, if t is higher than the marginal costs' difference, the platform always sets the fee so that the marginal consumer is indifferent between buying and not buying. Indeed, suppose that the indifferent consumer $\hat{x}_{s,p}$ has $U_s(\hat{x}_{s,p}) = U_p(\hat{x}_{s,p}) > 0$: then, it is always profitable for the platform to increase f, as this increases both his and the seller's prices, leaving market shares unaltered and increasing the platform's profits.

Finally, if the transportation costs are too high, the platform gives up on trying to keep the whole market covered and sets the fee to maximize the profits extraction from the seller.

Our analysis thus highlights how a hybrid platform is always able to avoid head-to-head competition with the seller. By strategically setting the per-transaction fee, the platform can induce a downstream monopoly if product differentiation is low or avoid competition if differentiation is high, even if both the platform and the seller are active and the market is fully (or partially) covered.

Concerning welfare, the following proposition summarizes the main findings.

Proposition 2. *If the platform is more cost-efficient, consumer surplus is maximized under monopolistic duopoly. If the seller is more cost-efficient, consumer surplus is maximized under monopolistic duopoly if $u > c_s + 4t$; else, is maximized if the seller covers the whole market ($t \leq \frac{c_p - c_s}{4}$).*

Proof. See the Appendix. □

As the platform can always avoid competition with the seller, consumer net utility can only be positive for consumers who are served by the seller. Then, if the platform serves the whole market, which can occur if the platform is more cost-efficient, consumers obtain zero net utility. Instead, if the seller serves the whole market, the platform sets the fee so high that, in equilibrium, the seller extracts most of the surplus from consumers, leaving them with $CS^* = \frac{t}{2}$.

Under monopolistic duopoly, the results concerning consumer surplus are more nuanced. Indeed, an increase in t has multiple effects. First, it increases the market share of the less efficient firm, as the more efficient one struggles to serve consumers located too far from its position. Second, it decreases the seller's price, as the equilibrium fee is also reduced. When the platform is more cost-efficient, these two effects are both positive for consumer surplus, as more consumers buy from the seller and at a lower price. Instead, if the seller is more cost-efficient, the first effect harms consumers as some of them start buying from the platform. In particular, if $t < c_p - c_s$, the first effect dominates the second, leading to a decrease in consumer surplus. Else, the second dominates the first and consumer surplus increases in t. In particular, under monopolistic duopoly, consumers are able to keep some of the gross utility u they derive from purchasing the good. Then, if such gross utility is high enough, consumers are better off under monopolistic duopoly than under the seller's monopoly.

With regard to total welfare, the only net loss that occurs in our model is the one caused by transportation costs. Then, intuitively, an increase in t always decreases total welfare.

5 Equilibrium with data-sharing

We now turn our attention to the case where the platform is mandated to share all his consumer data with the seller, thus enabling it to operate first-degree price discrimination too. In particular, both the platform and the seller can identify all consumers. To better understand how competition works in this framework, it is useful to sort consumers into three groups. The first one includes those consumers that can only be profitably targeted by the seller. Consequently, the seller offers them its tailored price $p_s^{TM}(x)$ and extracts all the surplus from them. Similarly, the second group includes those consumers that can only be profitably targeted by the platform. To them, the platform offers a tailored price $p_p^{TM}(x)$. Finally, the third group includes those consumers who can be reached by both the seller and the platform, and are thus contested. Since both firms can price discriminate, they can technically compete *à la Bertrand* for each consumer of the third group. To do so, they set a tailored price $p_k^{TC}(x)$.

The intense competition to *conquer* contested consumers generates ambiguous incentives on the platform. Because of the transportation costs, the seller has to offer consumers prices that are decreasing in the preference mismatch (i.e., the distance between consumers and firms' locations). However, the platform earns f from every consumer who purchases the seller's variety. Consequently, the platform may adopt sophisticated pricing strategies to *regulate* competition with the seller for consumers in the third group (i.e., contested ones). More specifically, the platform may not be able to extract at least $c_p + f$ via personalized pricing from consumers whose preferred variety is sufficiently far from variety p. In this case, allowing the seller to serve those consumers may be the most profitable choice. In other words, the platform has an opportunity cost that influences his business strategy.

To understand this, consider a platform with a marginal cost c_p. If there exist some consumers who are contested, then the platform's standard strategy is to offer $p_p^{TC}(x)$ and undercut the rival. However, if $p_p^{TC}(x) < c_p + f$, the profit the platform earns from winning the price competition is $p_p^{TC}(x) - c_p < f$. Instead, by giving up those consumers and allowing the seller to serve them, the platform earns f without producing anything (no costs involved). Thus, the platform prefers strategically losing price competition because it is more profitable to let the seller serve the market. Giving up the competition allows the seller to fully extract the surplus from those consumers.

Obviously, refraining from competing is a viable option if and only if consumers are contested (third group). Otherwise, if they cannot be profitably targeted by the seller, the platform earns nothing from not offering them a tailored price (his opportunity cost falls to zero). We define $\tilde{x}_{p2,no} > \tilde{x}_{p,no}$ the location of the last contested consumer that the platform can conquer with a price c_p+f. Figure 3 represents the combinations of market configurations and pricing strategies of the two firms graphically.

The following Proposition summarizes the equilibrium results and compares them to the no data-sharing case.

Proposition 3. *With data-sharing, monopolistic duopoly emerges for a wider range of t and the platform always avoids direct competition with the seller by setting a fee equal or higher*

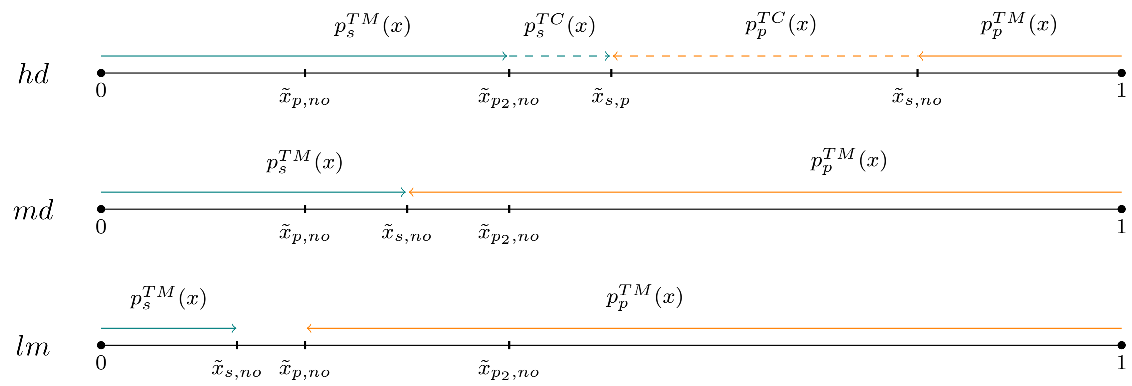

Figure 3: Market configuration and pricing strategies. When differentiation is high, firms are local monopolies (lm). If, instead, differentiation is low, firms compete in a Hotelling duopoly. Otherwise, firms operate in a monopolistic duopoly. The locations $\tilde{x}_{p,no}$ and $\tilde{x}_{s,no}$ identify the last consumers that the platform and the seller are able to target, respectively. Instead, $\tilde{x}_{p2,no}$ is the location of the last consumer the platform is willing to contest to the seller, provided that the latter can reach her. Practically, the seller faces no competition for all consumers $x \in (0, \tilde{x}_{p2,no})$.

than without data-sharing. The platform is always better off and consumers are always worse off with respect to the no data-sharing case. The seller's profits increase except if it is more efficient than the platform and differentiation is low.

Proof. See the Appendix. □

Our analysis highlights a perhaps counter-intuitive result that emerges when both the platform and the seller can price discriminate. The seminal literature on price discrimination in differentiated markets holds that if all firms have equal access to data and can use it to price discriminate, price wars ensue, lowering firms' profits for the benefit of consumers (Thisse and Vives, 1988). Our model suggests that this result may not resist in an environment where a vertically integrated platform competes against independent sellers in the platform's marketplace. More in detail, in our duopolistic setting, we show that when the seller obtains the ability to price discriminate, it becomes more aggressive from a competitive perspective. The platform reacts to the rise of competition intensity by strategically leaving a larger number of contested consumers to the seller, mitigating the negative effects on profits and leveraging on the transaction fee.[13] Hence, monopolistic duopoly emerges for a wider range of parameters, as we can see by comparing the red and the black solid lines in Figure 4.

It is also worth noting that the seller can be worse off under data-sharing. This occurs when the platform produces the final good at a higher marginal cost than the seller *and* the degree of horizontal differentiation t is sufficiently low. In this parameter region, the platform prefers not competing against the seller, regardless of the realized policy at Stage 0. In this cases, mandated data-sharing induces the platform to raise the commission fee which negatively

[13] Although raising the fee may not always be a viable solution for big platforms given the strict level of scrutiny authorities have adopted in their regards, other tools/strategies can be used to achieve the same outcome (e.g. shipping and delivery costs can be raised while keeping the fee fixed).

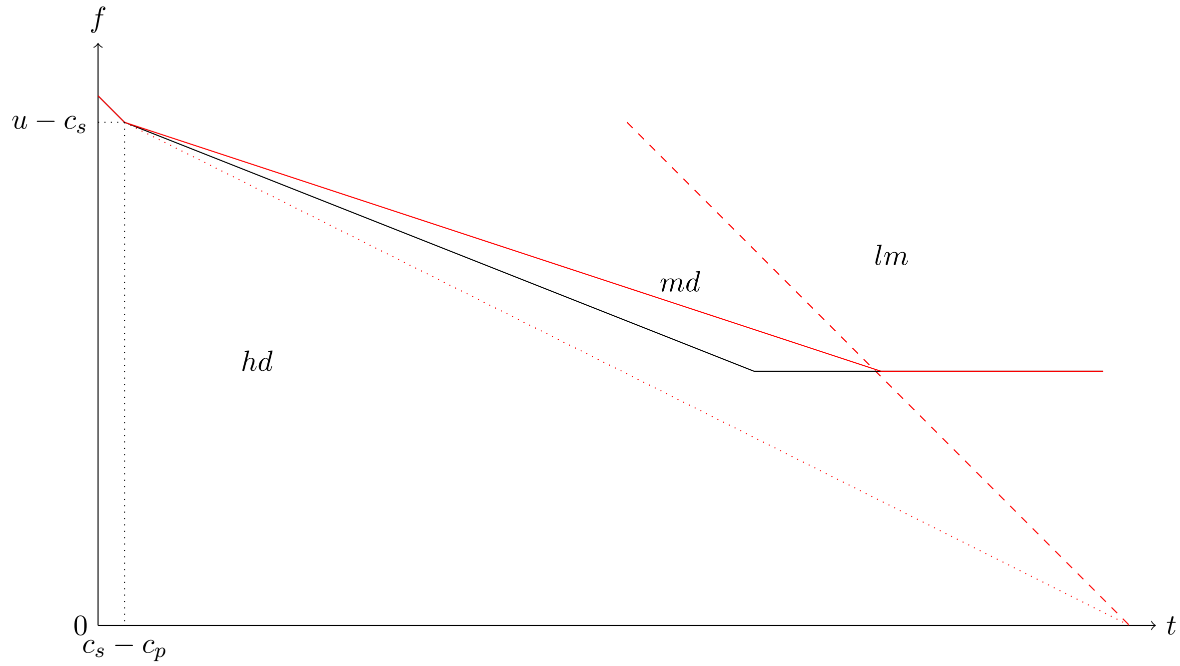

Figure 4: Equilibrium fee under data-sharing (solid red line) and under no data-sharing (solid black line) as a function of t. $u = 10, c_p = 0, c_s = 0.5$. Under data-sharing, Hotelling duopoly (hd) emerges under the dotted red line, local monopolies (lm) emerge above the dashed red line and monopolistic duopoly emerges between the two lines. In equilibrium, only monopolistic duopoly (md) and local monopolies (lm) emerge as equilibrium configurations. For $t \leq c_s - c_p$, the platform serves the whole market.

impacts the marginal costs of the seller. Ultimately, the increased data-driven pricing efficiency does not compensate for the higher costs of production, leaving the seller at a disadvantage: a policy that mandates data-sharing might increase costs for efficient sellers without improving their competitive position.

6 Policy discussion

In the previous section, our analysis has highlighted how the introduction of mandated data-sharing in hybrid platforms can have unintended consequences, increasing the platform's profits at the expense of consumers and, in some cases, of the seller. In this section, we analyze possible remedies that could revert such analysis.

First, we analyze a scenario in which a policymaker mandates data-sharing and does not allow the platform to change his equilibrium fee after data-sharing. This measure *de facto* reduces the fee paid by the seller after data-sharing, as described in Proposition 3. As discussed in the previous section, given that the platform may rely on multiple tools to achieve its optimal outcome, the intervention discussed above should be in practice extended beyond the fee to cover a wider set of contractual conditions set by the platform. The following Proposition summarizes the results of this scenario.

Proposition 4. *Suppose that a policymaker mandates data-sharing and forbids the platform from changing his fee. With respect to the case where the platform can adjust the fee, the platform is worse off, the seller is better off and consumers are indifferent.*

Proof. See the Appendix. □

The first two results of Proposition 4 are quite intuitive: as the fee under data-sharing decreases, the platform collects lower profits, and the seller can keep more of the revenues obtained from the consumers. However, consumer surplus is the same as in the scenario described in Section 5. To understand the intuition behind this result, let us refer again to Figure 4, where we show the equilibrium fee without data-sharing (black solid line) and the market configuration thresholds with data-sharing (red dashed and dotted lines). The local monopolies cases under data-sharing remain unaffected by the policy, as the equilibrium fee remains unchanged. Conversely, the monopolistic duopoly cases now face a lower equilibrium fee. However, the drop in the fee level is never enough to ensue direct competition between the seller and the platform, and consumers remain with zero utility. Finally, if differentiation is low, the market is only served by one firm. If the platform is more cost-efficient, then the platform's equilibrium fee level is the same under no data-sharing and under data-sharing, and the policy has no effect.[14] Instead, if the seller is more cost-efficient, the policy would result in a drop in the fee level. However, the drop would be again too small for competition to ensue, as the platform would still prefer the seller to serve all consumers as it is more efficient. We thus conclude that a policy that mandates the fee to not change after data-sharing would only benefit the seller and not consumers..

A second possible remedy would instead be to ban the hybrid business model altogether, resulting in the seller being a monopolist, whereas the platform only collects profits through the fee. The following Proposition summarizes the results of this scenario.

Proposition 5. *Under a ban of the hybrid model, seller's profits always increase both with or without data-sharing. Instead, consumer surplus only increases under no data-sharing.*

Proof. See the Appendix. □

The first result of Proposition 5 is intuitive: as the seller becomes a monopolist, it is able to serve more consumers and obtain higher profits. With regards to consumer surplus, it can only increase if the seller is not able to price discriminate. Indeed, under data-sharing, the seller would be able to extract all of consumers' utility, as it faces no competition. Instead, under no data-sharing, the seller sets the equilibrium price so that the utility of the consumer located in $\hat{x}_{s,no}$ is equal to zero. Then, it follows that all consumers in $[0, \hat{x}_{s,no}]$ obtain a positive utility.

Our analysis thus highlights how, even in the extreme case where banning a hybrid business model would result in a monopolistic market, such a ban can benefit consumers if it allows them

[14] In particular, the platform always sets $f^* = u - c_s$ so that the seller can never serve any consumer, and the platform can then extract all available surplus.

to avoid being price discriminated. Thus, we propose that the harm to competition comes from the platform's business model rather than from its information advantage.[15]

7 Conclusions

In recent years, hybrid marketplaces have drawn the attention of policymakers due to their dual role of hosting the marketplace while also competing in it, which raises concerns about anti-competitive behavior. The European Digital Markets Act has proposed a potential solution to this issue by mandating the sharing of consumer data between the platform and the sellers hosted on the marketplace, with the aim of creating a more level playing field in the downstream market.

In order to assess the impact of this remedy, we have designed a model in which a hybrid platform competes with a downstream independent seller in a market with horizontal differentiation. Our analysis documents that the platform, leveraging its data advantage to engage in price discrimination, can consistently avoid direct competition with the seller by strategically determining the per-transaction fee. This ability remains constant regardless of whether the independent seller can use data to engage in price discrimination or not. Although mandatory data-sharing implies even access to data and, thus, allows the seller to compete with the platform more aggressively, the platform can always set the transaction fee to ensure market segmentation, with the indifferent consumer receiving a net utility of zero, thereby preventing any form of direct competition in the marketplace.

This result is in stark contrast with the prior literature on first-degree price discrimination, which argues that symmetric access to data turns each consumer in a market, favoring competition. Indeed, the platform can adjust the fee to avoid competition with the seller. Consequently, consumers end up being worse off under data-sharing, as both the seller and the platform can extract all their surplus through tailored prices.

In light of these results, we analyze two possible complementary remedies. First, we investigate the effects of forbidding the platform from changing the fee after the data-sharing mandate. Although this remedy lowers the fee set by the platform, it is not enough to reinstate competition in the downstream market, leaving consumers indifferent. Second, we instead test the effects of banning the hybrid marketplace model, forbidding the platform from competing downstream. Our analysis shows that if data-sharing is *not* mandated, then consumers are actually better off. This somehow paradoxical finding highlights how, from a welfare perspective, the potential harm caused by a hybrid marketplace originates from its business model, not its data advantage. Banning the hybrid business model could benefit consumers, even if such a ban results in a downstream monopolistic seller.

Our analysis indicates that platform profits increase when data is shared. This result raises

[15] One should notice that the second half of Proposition 5 holds if and only if there is only one independent seller. In an environment with many independent sellers, the standard result in Thisse and Vives (1988) and Rhodes and Zhou (2024), among others, ensues, and full data-sharing benefits consumers. Still, our main message holds, as the competitive harm comes from the strategic interaction between the integrated platform and the sellers.

a natural question: If platforms unambiguously benefit from data-sharing, why should policy-makers mandate it? We propose two possible explanations. First, the platform might be better off with partial rather than total data-sharing. For example, platforms like Amazon allow sellers to access some data on the performance of their products, which reduces the information gap between the seller and the platform without eliminating it. If this is the case, sharing all data as our modeled policy mandates might be detrimental to the platform's optimal level of data-sharing but still better than not sharing any data. Our results support the idea that adjusting fees and effectively selling data is crucial for digital platforms. Indeed, we show that if the platform cannot adjust fees, the positive effects on its profits disappear.[16]

Second, and this represents a limitation of the model, we acknowledge that data-sharing could imply hidden costs that we fail to model. Data-sharing entails substantial investments in interoperability between sellers and buyers that might hinder its profitability. Moreover, it generates competitive risks that we left outside our model — e.g., access to data may allow some sellers to scale up their business operation and disintermediate from the platform.

These are all important features and additional research is needed to incorporate them into the analysis of the platform's incentives to engage in anti-competitive behavior. This work suggests that data-sharing does not unconditionally improve consumer welfare. In fact, it can be highly detrimental in those markets where the presence of the marketplace owner as a first-party seller is prominent.

[16] This is consistent with some services that Amazon provides to sellers. With its Strategic Account Services (SAS), Amazon provides consultancy services for pricing, distribution, and consumer review management in exchange for a fee surcharge. See https://sell.amazon.de/en/programme/strategic-account-services. Last access on May 17, 2024.

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Appendix

Proof of Lemma 1. The proof proceeds in three steps. First, we focus on the seller's and platform's equilibrium strategies as a function of t and f if the seller prices as a monopolist. Second, we focus on the equilibrium strategies if the seller prices competitively. Third, by comparing the seller's strategies, we find the conditions on t for which it chooses one or the other.

Step 1. Suppose the seller prices as a monopolist. By this terminology we refer to the case where the seller ignores the platform's presence, and sets its equilibrium price as if it was the only firm in the market. The consumer utility when buying from the seller is

$$U_s(x) = u - tx - p_s. \tag{A.1}$$

Byu binding (A.1), the last consumer who would buy from the seller is located in

$$\hat{x}_{s,no} = \frac{u - p_s}{t} \tag{A.2}$$

If the seller acts as a monopoli2t,it serves consumers up to (A.2) and sets the equilibrium price to maximize

$$\pi_s = \hat{x}_{s,no}(p_s - c_s - f), \tag{A.3}$$

Maximization of (A.3) leads to

$$p_s^{M*} = \frac{u + c_s + f}{2} \tag{A.4}$$

where the superscript M denotes the seller's strategy of pricing as a monopolist. This strategy is an equilibrium for the seller as long as $\hat{x}_{s,no} \leq 1$: afterwards, the seller would set its price so that the consumer located in $x = 1$ obtains a net utility equal to zero. Combining (A.4) and binding (A.1) for $x = 1$, we find that

$$p_s^{M*} = \begin{cases} \frac{u+c_s+f}{2} & \text{for } t > \frac{u-f-c_s}{2} \\ u - t & \text{for } t \leq \frac{u-f-c_s}{2} \end{cases}$$

Having found the seller's equilibrium strategy, let us instead focus on the platform. If the platform poaches a consumer from the seller, he gains $p_p - c_p$ but loses f as he will not obtain the per-transaction fee from the seller. Thus, the platform is only interested in serving consumers from which he can extract $p_p - c_p \geq f$.

As a starting point, suppose that u and f are low enough so that $t \leq \frac{u-f-c_s}{2}$. Then, the seller sets $p_s^{M*} = u - t$. Recall that the platform can first-degree price discriminate consumers. Then, the platform sets a location-dependent price to match the seller's offer in utility. By equating a generic consumer utility when buying from either the seller or the platform and solving for p_p, we obtain

$$p_p^*(x) = u - 2t + 2tx. \tag{A.5}$$

To find which consumers the platform serves in equilibrium, we search for the consumer for which $p_p^*(x) - c_p = f$. By applying (A.5), we find

$$x^* = \frac{c_p + f + 2t - u}{2t}.$$

If $x^* \leq 0$, in equilibrium the platform serves all consumers. If $x^* \geq 1$, in equilibrium the seller serves all consumers. Else, some consumers buy from the platform and some from the sellers. We thus analyze the conditions under which $x^* \leq 0$ or $x^* \geq 1$, recalling that we have assumed $t \leq \frac{u-f-c_s}{2}$.

First, we find that $x^* \leq 0$ is always satisfied if $c_p \leq c_s$ and is satisfied for $t \leq \frac{u-f-c_p}{2}$ if $c_p > c_s$. In other words, if the seller can potentially serve all consumers in the market, the platform always serves all consumers if he is more cost-efficient, or if he is less cost-efficient and differentiation is low enough.

Second, we instead find that $x^* \geq 1$ iff $c_s < c_p, t < \frac{c_p - c_s}{2}$ and $f \geq u - c_p$. In other words, the platform would leave all the market to the seller only if the seller is more cost-efficient, differentiation is low and the per transaction fee is so high that the platform prefers not serving the consumer located on his same position.

If the platform covers the whole market, profits are:

$$\pi_s^* = 0 \quad \text{and} \quad \pi_p^* = \int_0^1 p_p^*(x) - c_p \quad dx = u - t - c_p. \tag{A.6}$$

Instead, if the platform and the seller split the market, profits are

$$\pi_s^* = (u - t - c_s - f)x^* = \frac{(c_p + f + 2t - u)(u - t - f - c_s)}{2t} \tag{A.7}$$

$$\pi_p^* = \int_{x^*}^1 p_p^*(x) - c_p \quad dx + fx^* = \frac{c_p^2 + 2c_p f + f^2 + 4ft - 2u(c_p + f) + u^2}{4t} \tag{A.8}$$

We now proceed to the case where the seller cannot potentially serve all consumers, i.e., $t > \frac{u-f-c_s}{2}$. In such cases, the seller sets $p_s^{M^*} = \frac{u+f+c_s}{2}$, and the platform's tailored price becomes $p_p^*(x) = \frac{c_s+f-2t+u+4tx}{2}$. The last consumer that the seller can potentially serve is located in $\hat{x}_{s,no} = \frac{u-f-c_s}{2t}$, and the last consumer that the platform can profitably serve is located in $x^* = \frac{2c_p - c_s + f + 2t - u}{4t}$. By focusing on the new value of x^*, we find that the platform serves all consumers only if $c_p \leq c_s$ and $t < \frac{u-f+c_s-2c_p}{2}$. In such cases, the seller makes zero profits. The platform sets $p_p(x) = p_p^*(x)$ for the consumers located in $[0, \hat{x}_{s,no}]$; instead, for consumers in $[\hat{x}_{s,no}, 1]$, he sets $p_p(x) = u - t + tx$ to extract all available utility. Platform's profits are thus equal to

$$\pi_p^* = \int_0^{\hat{x}_{s,no}} p_p^*(x) - c_p \quad dx + \int_{\hat{x}_{s,no}}^1 u - t + tx - c_p \quad dx = -\frac{(c_s+f)^2 + 4t(2c_p+t) - 2u(4t+f+c_s) + u^2}{8t}. \tag{A.9}$$

Instead, if $t > \frac{u-f+c_s-2c_p}{2}$, the seller and the platform split the market, with the seller serving consumers in $[0, x^*]$ and the platform serving the remaining consumers. We thus obtain

$$\pi_s^* = \frac{(c_s+f-u)(u-2t-f+c_s-2c_p)}{8t} \tag{A.10}$$

$$\pi_p^* = -\frac{-4c_p^2 + 4c_p(c_s - f + 2t + u) + c_s^2 + c_s(6f + 4t - 6u) - 2u(f+6t) + (f-2t)^2 + u^2}{16t} \tag{A.11}$$

As long as $\hat{x}_{s,no} \leq x^*$, all consumers that can potentially be served by both firms are served by the seller in equilibrium. However, once $t > \frac{3u-3f-2c_p-c_s}{2}$, we instead have that $\hat{x}_{s,no} > x^*$: then, consumers in $[0, \hat{x}_{s,no}]$ are served by the seller, and the remaining consumers are served by the platform. We obtain

$$\pi_s^* = \frac{(c_s+f-u)^2}{4t} \tag{A.12}$$

$$\pi_p^* = -\frac{4(c_p+t-u)(c_s+f+2t-u) + (c_s+f-u)^2 + 4f(c_s+f-u) - 4t^2}{8t} \tag{A.13}$$

Finally, if t increases too much, there will be a set of consumers that cannot be served neither by the seller nor the platform. Formally, this happens when $\hat{x}_{s,no} < \hat{x}_{p,no}$, which is satisfied for $t > \frac{3u-f-2c_p-c_s}{2}$. Under this condition, the seller serves consumers in $[0, \hat{x}_{s,no}]$, and the platform serves consumers in $[\hat{x}_{p,no}, 1]$ at a price $p_p(x) = u - t + tx$, leading to

$$\pi_s^* = \frac{(c_s+f-u)^2}{4t} \tag{A.14}$$

$$\pi_p^* = \frac{c_p^2 - 2c_p u - f(c_s+f) + u(f+u)}{2t} \tag{A.15}$$

Suppose $c_p \leq c_s$: by combining (A.6), (A.10) and (A.12) for the seller's profits and (A.6), (A.9), (A.11), (A.13) and (A.15), for the platform's profits we obtain the following profit functions.

$$\pi_s^{M*} = \begin{cases} 0 & \text{for } 0 < t < \frac{u-f+c_s-2c_p}{2} \\ \frac{(c_s+f-u)(u-2t-f+c_s-2c_p)}{8t} & \text{for } \frac{u-f+c_s-2c_p}{2} \leq t < \frac{3u-3f-c_s-2c_p}{2} \\ \frac{(c_s+f-u)^2}{4t} & \text{for } t \geq \frac{3u-3f-c_s-2c_p}{2} \end{cases} \tag{A.16}$$

$$
\pi_p^* = \begin{cases} u-t-c_p & \text{for } 0<t<\frac{u-f-c_s}{2} \\ -\frac{(c_s+f)^2+4t(2c_p+t)-2u(4t+f+c_s)+u^2}{8t} & \text{for } \frac{u-f-c_s}{2}\leq t<\frac{u-f+c_s-2c_p}{2} \\ -\frac{-4c_p^2+4c_p(c_s-f+2t+u)+c_s^2+c_s(6f+4t-6u)-2u(f+6t)+(f-2t)^2+u^2}{16t} & \text{for } \frac{u-f+c_s-2c_p}{2}\leq t<\frac{3u-3f-c_s-2c_p}{2} \\ -\frac{4(c_p+t-u)(c_s+f+2t-u)+(c_s+f-u)^2+4f(c_s+f-u)-4t^2}{8t} & \text{for } \frac{3u-3f-c_s-2c_p}{2}\leq t<\frac{3u-f-2c_p-c_s}{2} \\ \frac{c_p^2-2c_pu-f(c_s+f)+u(f+u)}{2t} & \text{for } t\geq\frac{3u-f-2c_p-c_s}{2} \end{cases} \tag{A.17}
$$

Instead, if $c_p > c_s$, by combining (A.6), (A.7), (A.10) and (A.12) for the seller's profits and (A.6), (A.8), (A.11), (A.13) and (A.15) for the platform's profits we obtain the following profit functions.

$$
\pi_s^{M*} = \begin{cases} 0 & \text{for } 0<t<\frac{u-f-c_p}{2} \\ \frac{(c_p+f+2t-u)(-c_s-f-t+u)}{2t} & \text{for } \frac{u-f-c_p}{2}\leq t<\frac{u-f-c_s}{2} \\ \frac{(c_s+f-u)(u-2t-f+c_s-2c_p)}{8t} & \text{for } \frac{u-f-c_s}{2}\leq t<\frac{3u-3f-c_s-2c_p}{2} \\ \frac{(c_s+f-u)^2}{4t} & \text{for } t\geq\frac{3u-3f-c_s-2c_p}{2} \end{cases} \tag{A.18}
$$

$$
\pi_p^* = \begin{cases} u-t-c_p & \text{for } 0<t<\frac{u-f-c_p}{2} \\ \frac{c_p^2+2c_pf+f^2+4ft-2u(c_p+f)+u^2}{4t} & \text{for } \frac{u-f-c_p}{2}\leq t<\frac{u-f-c_s}{2} \\ -\frac{-4c_p^2+4c_p(c_s-f+2t+u)+c_s^2+c_s(6f+4t-6u)-2u(f+6t)+(f-2t)^2+u^2}{16t} & \text{for } \frac{u-f-c_s}{2}\leq t<\frac{3u-3f-c_s-2c_p}{2} \\ -\frac{4(c_p+t-u)(c_s+f+2t-u)+(c_s+f-u)^2+4f(c_s+f-u)-4t^2}{8t} & \text{for } \frac{3u-3f-c_s-2c_p}{2}\leq t<\frac{3u-f-2c_p-c_s}{2} \\ \frac{c_p^2-2c_pu-f(c_s+f)+u(f+u)}{2t} & \text{for } t\geq\frac{3u-f-2c_p-c_s}{2} \end{cases} \tag{A.19}
$$

Step 2. Suppose instead that the seller prices competitively, as in the standard Hotelling model. Similarly to Step 1, suppose that t and f are low enough so that both firms can potentially serve all consumers. By equating consumers' utilities when buying from the platform or the seller, the indifferent consumer is located in

$$
\hat{x}_{s,p} = \frac{p_p - p_s + t}{2t} \tag{A.20}
$$

Moreover, the platform sets tailored prices $p_p(x)$ so that he matches the seller's offer in utility. We thus have

$$
p_p(x) = p_s - t + 2tx \tag{A.21}
$$

By applying (A.20) and (A.21), seller's and platform's profits can be thus written as

$$
\pi_s = \hat{x}_{s,p}(p_s - c_s - f) \tag{A.22}
$$

$$
\pi_p = \int_{\hat{x}_{s,p}}^{1} (p_p(x) - c_p dx) + f\hat{x}_{s,p} \tag{A.23}
$$

By simultaneously maximizing (A.22) and (A.23) with respect to p_s and p_p respectively, we obtain

$$p_s^{C*} = \frac{c_p + c_s + 2f + t}{2} \quad \text{and} \quad p_p^* = c_p + f, \tag{A.24}$$

where the superscript C denotes that the seller prices competitively. Note that $c_p + f$ is also the lowest tailored price the platform would offer, as any lower price would grant lower profits with respect to leaving that consumer to the selle6. Applying (A.24), equilibrium profits are

$$\pi_s^{C*} = \frac{(t + c_p - c_s)^2}{8t} \quad \text{and} \quad \pi_p^* = \frac{(c_p - c_s)^2 + 2t(8f + 3(c_s - c_p)) + 9t^2}{16t}. \tag{A.25}$$

The indifferent consumer is located in $\hat{x}_{s,p}^* = \frac{c_p - c_s + t}{4t}$.

First, suppose the platform is more cost-efficient: then, if $t \leq c_s - c_p, \hat{x}_{s,p}^* \leq 0$ and the platform obtains the whole market, as the seller sets its basic price at its minimum, $p_s^{C*} = c_s + f$. Platform's profits thus become

$$\pi_p^* = f + c_s - c_p. \tag{A.26}$$

However, this strategy only holds as long as all consumers prefer buying from the platform rather than not buying. The consumer located in $x = 1$, who is the closest to the platform, is the one facing the highest price, and becomes indifferent between buying and not buying once $f = \frac{2u - 3t - c_p - c_s}{2}$. for fees higher than this threshold, the platform must adjust the price offered to close consumers, setting a targeted price equal to their residual utility, i.e., $p_p(x) = u - t(1 - x)$. In particular, such price is offered to consumers located in $x \geq \frac{2u - t - 2f - c_p - c_s}{2}$, leading to platform's profits being equal to

$$\pi_p^* = -\frac{-c_p^2 + 2c_p(c_s + 3t) + 3c_s^2 - 8u(c_s + f + t) + 8c_s f + 2c_s t + 4f^2 + 3t^2 + 4u^2}{8t} \tag{A.27}$$

Finally, after $f > u - c_s$, the seller can no longer profitably serve any consumer in the market. The platform then extracts all available surplus from consumers, leading to profits

$$\pi_p^* = u - \frac{t}{2} - c_p \tag{A.28}$$

Second, suppose instead that the seller is more cost-efficient. Then, if $t < \frac{c_p - c_s}{3}$, $\hat{x}_{s,p}^* \geq 1$ and the seller serves the whole market. The seller then sets its basic price so that the consumer located in $x = 1$ is indifferent between buying from it or buying from the platform at his lowest price, i.e., $p_p(1) = c_p + f$, leading to $p_s^{C*} = c_p + f - t$. Seller's and platform's profits become

$$\pi_s^{C*} = c_p - c_s - t \quad \text{and} \quad \pi_p^* = f. \tag{A.29}$$

Having analyzed the scenarios when t is low, we now focus on how competition changes as t increases. An increase in t increases the prices posted by the seller and the platform. In particular, the consumer with the lowest net utility is the one located in $x = 1$, as the platform extracts most of her surplus. Once $t = \frac{2u - 2f - c_p - c_s}{3}$, the consumer located in $x = 1$ would not buy from either the seller or the platform. Then, as previously seen, the platform adjusts the tailored price to extract all the consumer's utility, i.e., $p_p(x) = u - t(1-x)$, and does so for all consumers in $[\frac{2u-t-2f-c_p-c_s}{2t}]$. Seller's profits are unaffected by the platform's strategy change, whereas platform's profits become

$$\pi_p^* = -\frac{c_p^2 - 8u(c_p + c_s + 2f + 3t) + 6c_pc_s + 8c_pf + 18c_pt + c_s^2 + 8c_sf + 6c_st + 8f^2 + 8ft + 9t^2 + 8u^2}{16t}. \tag{A.30}$$

As t continues to increase, the number of consumers who are indifferent between buying and not buying increases. In particular, once $t = \frac{4u-4f-c_s-3c_p}{3}$, the last consumer who buys from the seller, located in $\hat{x}_{s,p}$, obtains a net utility equal to zero. Thus, for $t > \frac{4u-4f-c_s-3c_p}{3}$, the seller starts losing market share, which in turn is conquered by the platform by offering $p_p(x) = u-t(1-x)$. The last consumer buying from the seller is located in $\hat{x}_{s,no} = \frac{2u-t-2f-c_p-c_s}{2}$, and profits become

$$\pi_s^{C*} = \frac{(c_p - c_s + t)(2u - t - 2f - c_s - c_p)}{4t} \tag{A.31}$$

$$\pi_p^* = -\frac{5c_p^2 + 2c_p(3c_s + 8f + 9t - 8u) + c_s^2 - 8u(c_s + 3(f+t)) + 8c_sf + 6c_st + 12f^2 + 16ft + 9t^2 + 12u^2}{8t}. \tag{A.32}$$

As t increases even further, less consumers would want to buy from the seller, as $\hat{x}_{s,no}$ approaches zero. However, we must check whether $\hat{x}_{s,no}$ reaches zero before or after $\hat{x}_{p,no}$. If so, once $\hat{x}_{s,no} = 0$, the seller becomes inactive and the platform covers the whole market. Else, there exists a threshold in t after which both the seller and the platform are active, but some consumers do not buying equilibrium. Note that in this scenario, if the platform does not serve a consumer, that consumer does not buy in equilibrium. Then, the lowest price the platform can offer is equal to c_p instead of $c_p + f$.

By comparing the expressions of $\hat{x}_{s,no}$ and $\hat{x}_{p,no} = \frac{c_p+t-u}{t}$, we find that $\hat{x}_{s,no}$ reaches zero before $\hat{x}_{p,no}$ if $f \geq \frac{u-c_s}{2}$. Suppose such a condition holds. Then, once $\hat{x}_{s,no} = 0$, which happens for $t = 2u - 2f - c_p - c_s$, the seller is inactive and the platform covers the whole market, obtaining profits equal to

$$\pi_p^* = u - \frac{t}{2} - c_p. \tag{A.33}$$

Such result holds as long as $\hat{x}_{p,no} \leq 0$, so that the platform serves all consumers. Once $t > u-c_p$, $\hat{x}_{p,no} > 0$ and the market is partially covered, leading to platform's profits equal to

$$\pi_p^* = \frac{(c_p - u)^2}{2t} \tag{A.34}$$

Suppose instead that $f < \frac{u-c_s}{2}$. Then, once $t = \frac{4u-2f-c_s-3c_p}{3}$, we have $\hat{x}_{p,no} = \hat{x}_{s,no}$. After this t threshold, the market is partially covered and profits are equal to:

$$\pi_s^{C*} = -\frac{(c_p - c_s + t)(c_p + c_s + 2f + t - 2u)}{4t}$$

$$\pi_p^* = \frac{(c_p - u)^2 - f(c_p + c_s + 2f + t - 2u)}{2t} \tag{A.35}$$

Finally, once $t > 2u - 2f - c_p - c_s$, the seller is inactive and platform's profits are as in (A.34) which completes the analysis.

Step 3. Having found the seller's equilibrium profits both when it prices as a monopolist and when it prices competitively, we now compare the profit's functions to understand for which range of parameters t and f one strategy dominates the other.

By comparing the profit's functions under different values of t, we find that competitive pricing dominates monopolistic pricing for low values of t, and the opposite is true for high values of t. Regardless of the relationship between c_p and c_s, we find that the result is ambiguous in for the range $\frac{4u-4f-3c_p-c_s}{3} < t < \frac{3u-3f-2c_p-c_s}{2}$. In such a range, the seller's profits when pricing competitively are

$$\pi_s^{C*} = \frac{(c_p - c_s + t)(2u - t - 2f - c_s - c_p)}{4t},$$

whereas its profits when pricing as a monopolist are

$$\pi_s^{M*} = \frac{(c_s + f - u)(u - 2t - f + c_s - 2c_p)}{8t}.$$

By posing $\pi_s^{M*} \geq \pi_s^{C*}$, we find that the condition holds iff

$$t \geq \bar{t} = \frac{1}{2}(-2c_p + c_s - f + u) + \frac{1}{2}\sqrt{3}\sqrt{c_s^2 + 2c_s f - 2c_s u + f^2 - 2fu + u^2}$$

. Thus, if $t \geq \bar{t}$, the seller prices as a monopolist. Else, it prices competitively.

Proof of Lemma 2. The results of this lemma directly stem from the results described in Lemma 1. As concluded in Step 3 of the proof of Lemma 1, if $t < \frac{4u-4f-3c_p-c_s}{3}$, the seller prices competitively and the last consumer who is buying from the seller obtains positive utility. Thus, for $t < \frac{4u-4f-3c_p-c_s}{3}$, we have Hotelling Duopoly. Conversely, if $t > \frac{3u-f-2c_p-c_s}{2}$, the seller always prices as a monopolist, and the market is partially covered as we observe local monopolies. Finally, for $\frac{4u-4f-3c_p-c_s}{3} \leq t \leq \frac{3u-f-2c_p-c_s}{2}$, the seller can either price competitively or as a monopolist, but monopolistic duopoly always ensues.

Proof of Proposition 1. To find the equilibrium level of f and, in turn, of prices, we compare the platform's profits as a function of f. In particular, the platform anticipates if the seller behaves competitively or as a monopolist, depending on the level of f he chooses. Platform's profits are expressed as in (A.17) and (A.19) if the seller prices monopolistically, and as in (A.25), (A.26), (A.27), (A.28), (A.29), (A.30), (A.32), (A.33), (A.34) and (A.35) if the seller prices competitively (depending on the levels of t, c_p, c_s and f).

First, suppose that $c_p \leq c_s$. As concluded in Lemma 1, if $t \leq c_s - c_p$, the platform serves all consumers if $t \leq \frac{u-f-c_s}{2}$. Depending on the level of f, platform's profits are as in (A.26), (A.27) or (A.28), as the seller adjusts its basic price depending on f. By comparing platform's profits, we find that they are maximized for any $f > \frac{2u-t-c_p-c_s}{2}$, after which all consumers are indifferent between buying or not buying.

Second, suppose that $t > |c_s - c_p|$. To find the equilibrium f, we proceed by deriving platform's profits with respect to f in a given range of t, searching for the f^* that maximizes such profits and checking if the f^* actually allows the platform to end up in the specified range of t. By applying this method to all of the platform's profits when the seller prices competitively, we find that platform's profits are increasing in f for the specified ranges of t, and their maxima always fall outside of the specified range of t. Thus, we conclude that if $t > |c_s - c_p|$, the platform sets f too high for the seller to price competitively. Shifting our analysis to the case in which the seller prices as a monopolist, we find that the only case where f^* falls within the specified range of t is if $\frac{3u-3f-c_s-2c_p}{2} \leq t < \frac{3u-f-2c_p-c_s}{2}$. For such range, the platform sets $f^* = \frac{5u-2c_p-3c_s-2t}{5}$ and monopolistic duopoly ensues, as described in equations (A.12) and (A.13). In particular, the condition $t < \frac{3u-f-2c_p-c_s}{2}$ becomes $t < \frac{5u-c_s-4c_p}{4}$

Once $t \geq \frac{5u-c_s-4c_p}{4}$, differentiation is too high to sustain monopolistic duopoly. Then, the platform maximizes his profits under the local monopoly case (equations (A.14) and (A.15)). By maximizing them with respect to f, we find $f^* = \frac{u-c_s}{2}$.

Finally, suppose that $c_p > c_s$ and $t < c_p - c_s$. We start our analysis from the monopolistic duopoly equilibrium described above, where the platform sets $f^* = \frac{5u-2c_p-3c_s-2t}{5}$. By replacing f^*, in the indifferent consumers' locations, we find that the seller covers the whole market once $t \leq \frac{c_p-c_s}{4}$. Once the seller covers up the whole market, the platform has an incentive to raise f as long as the seller continues to serve the whole market. As concluded in Step 1 of the proof of Lemma 1, this happens as long as $t \leq \frac{u-f-c_s}{2}$. Then, the equilibrium platform's strategy is to set $f^* = u - c_s - 2t$ and only obtain profits through f^*.

Note that in this last scenario, pricing competitively is never optimal for the seller. Indeed, the seller serves the whole market as long as the consumer located in $x = 1$ is indifferent between buying from the seller or from the platform. The lowest price the platform offers is $p_p^T(x) = c_p + f$, and thus the seller must offer $p_s = c_p + f - t$. However, this only holds as long as the net utility of the consumer located in $x = 1$ is greater or equal than zero. In particular, the net utility of the consumer located in $x = 1$ is lower than zero if $f > \hat{f} = u - c_p$. Above this threshold, the seller is not able to serve the whole market by pricing competitively. By comparing $f^* = u - c_s - 2t$ and $\hat{f} = u - c_p$, we find that $f^* \geq \hat{f}$ as long as $t \leq \frac{c_p-c_s}{4}$, which is the condition found for the equilibrium above. Thus, for $c_p > c_s$ and $t \leq \frac{c_p-c_s}{4}$, the seller prices as a monopolist and covers the whole market.

Proof of Proposition 2 The proof proceeds in two steps. In Step 1 we find consumer surplus when the platform is more cost-efficient. In Step 2, we find consumer surplus when the seller is more cost-efficient.

Step 1. Suppose that $c_p \leq c_s$. Depending on the level of horizontal differentiation, three scenarios can arise. If $t \leq c_s - c_p$, all consumers are served by the platform, who extracts all available surplus from them. It follows that $CS^* = 0$. If $c_s - c_p < t < \frac{5u-c_s-4c_p}{4}$, monopolistic duopoly ensues. Then, consumers buying from the platform obtain net utility equal to zero, as he extracts all available surplus. Conversely, the surplus of consumers buying from the seller can be computed as

$$CS^* = \int_0^{\hat{x}_{s,no}} u - tx - p_s^* dx, \tag{A.36}$$

where $\hat{x}_{s,no} = \frac{u-f-c_s}{2t}$, $p_s^* = \frac{u+c_s+f^*}{2}$ and $f^* = \frac{5u-2c_p-3c_s-2t}{5}$. The same also holds if $t \geq \frac{5u-c_s-4c_p}{4}$. However, under these circumstances, we have that $f^* = \frac{u-c_s}{2}$. By applying (A.36), we obtain

$$CS^* = \begin{cases} 0 & \text{for } 0 < t < c_s - c_p \\ \frac{\left(\frac{1}{5}(-2c_p-3c_s-2t+5u)+c_s-u\right)^2}{4t} & \text{for } c_s - c_p \leq t < \frac{5u-c_s-4c_p}{4} \\ \frac{\left(\frac{u-c_s}{2}+c_s-u\right)^2}{4t} & \text{for } t \geq \frac{5u-c_s-4c_p}{4} \end{cases}$$

By comparing the outcomes under different levels of t, we find that consumer surplus is maximized if $c_s - c_p \leq t < \frac{5u-c_s-4c_p}{4}$, i.e., under monopolistic duopoly.

Step 2. Suppose instead that $c_s < c_p$. With respect to the analysis portrayed in Step 1, there are two differences. First, the lower threshold of t for the existence of monopolistic duopoly becomes $\frac{c_p-c_s}{4}$. Second, if $t < \frac{c_p-c_s}{4}$, all consumers are served by the seller and can obtain positive utility, as the seller offer a price $p_s^* = u - t$ By again applying (A.36), we obtain

$$CS^* = \begin{cases} \int_0^1 u - tx - (u-t)dx = t & \text{for } 0 < t < \frac{c_p-c_s}{4} \\ \frac{\left(\frac{1}{5}(-2c_p-3c_s-2t+5u)+c_s-u\right)^2}{4t} & \text{for } \frac{c_p-c_s}{4} \leq t < \frac{5u-c_s-4c_p}{4} \\ \frac{\left(\frac{u-c_s}{2}+c_s-u\right)^2}{4t} & \text{for } t \geq \frac{5u-c_s-4c_p}{4} \end{cases}$$

By comparing consumer surplus under the different scenarios, we find that consumer surplus is maximized under monopolistic duopoly as long as $u > c_s + 4t$; else, it is maximized in the first scenario where the seller serves all consumers.

Proof of Proposition 3 The proof proceeds in three steps. In Step 1, we find all possibile competitive scenarios as a function of t and f. In Step 2, we find the equilibrium fee f^* and show the equilibrium outcomes for any t. In Step 3, we provide a welfare analysis.

Step 1. If both the seller and the platform can price discriminate, they compete head-to-head over every individual consumer they can profitably serve.

As a starting point, suppose that t is so high that the market is partially covered. Both the seller and the platform can extract all utility from consumers, and thus set their prices such that $U_s(x) = u - p_s(x) - tx = 0 \rightarrow p_s(x) = u - tx$ and $U_p(x) = u - p_p(x) - t(1-x) = 0 \rightarrow p_p(x) = u - t + tx$. The last consumer buying from the seller is thus located in $\hat{x}_{s,no} = \frac{u-c_s-f}{t}$, and the last consumer buying from the platform is located in $\hat{x}_{p,no} = \frac{c_p+t-u}{t}$, and profits are equal to

$$\pi_s = \frac{(c_s + f - u)^2}{2t} \tag{A.37}$$

and

$$\pi_p = \frac{c_p^2 - 2f(c_s+f) - 2c_pu + 2fu + u^2}{2t}, \tag{A.38}$$

respectively. By imposing $\hat{x}_{s,no} \geq \hat{x}_{p,no}$, we find that once $t \leq 2u - f - c_p - c_s$ the market is completely covered.

Once t is above this threshold, consumers located in $[\hat{x}_{p,no}, \hat{x}_{s,no}]$ can be profitably served by both firms. However, the platform chooses to poach a consumer from the seller only if selling directly grants higher profits than collecting the fee from the seller, which holds only if $p_p(x) > c_p + f$. We denote as $\hat{x}_{p2,no} = \frac{c_p+f+t-u}{t}$, the location of the last consumer that the platform prefers to serve rather than leaving her to the seller. Thus, once $t \geq 2u - f - c_p - c_s$, all contestable consumers are served by the seller as long as $\hat{x}_{s,no} < \hat{x}_{p2,no}$, and profits become

$$\pi_s = \frac{(c_s + f - u)^2}{2t} \tag{A.39}$$

and

$$\pi_p = -\frac{2c_p(c_s + f + t - u) + c_s^2 + 2c_s(2f + t - 2u) + 3f^2 + 2ft - 6fu + t^2 - 4tu + 3u^2}{2t}, \tag{A.40}$$

respectively. By imposing $\hat{x}_{s,no} \geq \hat{x}_{p2,no}$, we find that if $t \leq 2u - 2f - c_p - c_s$, the platform stops leaving all contestable consumers to the seller and prefers to directly serve some of them.

If $t \leq 2u - 2f - c_p - c_s$, we have the following scenario. Consumers in $[0, \hat{x}_{p,no}]$ can only be profitably served by the seller, who extracts all surplus from them. Consumers in $[\hat{x}_{p,no}, \hat{x}_{p2,no}]$ could be contested by the platform, but the platform prefers to leave them to the seller. Consumers in $[\hat{x}_{s,no}, 1]$ can only be profitably served by the platform, who extracts all surplus from them. Finally, consumers in $[\hat{x}_{p2,no}, \hat{x}_{s,no}]$ are contested and the platform wants to poach them from the seller. The lowest price the seller can offer is $p_s(x) = c_s + f$, and the lowest price the platform can offer is $p_p = cp + f$. It follows that the consumer who is indifferent between these two prices is located in $\hat{x}_{s,p} = \frac{c_p - c_s + t}{2t}$. Thus, consumers in $[\hat{x}_{p2,no}, \hat{x}_{s,p}]$ are served by the seller who undercuts the platform by offering $p_s(x) = c_p + f + t - 2tx$ to those consumers, whereas consumers in $[\hat{x}_{s,p}, \hat{x}_{s,no}]$ are served by the platform who undercuts the seller by offering $p_p(x) = c_s + f - t + 2tx$ to those consumers. By integrating the proper prices over the market shares, we find that profits are equal to

$$\pi_s = -\frac{c_p^2 + 2c_p(c_s + 2f + t - 2u) - c_s^2 + 2c_s t + 2f^2 - 4u(f + t) + 4ft + t^2 + 2u^2}{4t} \tag{A.41}$$

and

$$\pi_p = -\frac{-c_p^2 + 2c_p(c_s + t) + c_s^2 - 4u(c_s + f + t) + 4c_s f + 2c_s t + 2f^2 + t^2 + 2u^2}{4t}, \tag{A.42}$$

respectively.

As t decreases further, $\hat{x}_{s,no}$ shifts towards 1, whereas $\hat{x}_{p,no}$ and $\hat{x}_{p2,no}$ shift toward 0. We focus our analysis on $\hat{x}_{s,no}$ and $\hat{x}_{p2,no}$. If $c_p < c_s$, we have that $\hat{x}_{p2,no}$ reaches 0 before $\hat{x}_{s,no}$ reaches 1. In particular, $\hat{x}_{p2,no} = 0$ for $t = u - f - c_p$. Below this threshold, all consumers in $[0, \hat{x}_{s,no}]$ are contested between the platform and the seller, whereas consumers in $[\hat{x}_{s,no}, 1]$ are only served by the platform. Integrating the prices over the relevant market shares results in

$$\pi_s = \frac{(c_p - c_s + t)^2}{4t} \tag{A.43}$$

and

$$\pi_p = -\frac{-c_p^2 + 2c_p(c_s + t) + c_s^2 - 4u(c_s + f + t) + 4c_s f + 2c_s t + 2f^2 + t^2 + 2u^2}{4t}, \tag{A.44}$$

respectively. Once $t < u - f - c_s$, also the seller can profitably serve all consumers as $\hat{x}_{s,no} > 1$. Profits become

$$\pi_s = \frac{(c_p - c_s + t)^2}{4t} \tag{A.45}$$

and

$$\pi_p = \frac{2t(-c_p + c_s + 2f) + (c_p - c_s)^2 + t^2}{4t}, \tag{A.46}$$

respectively. Finally, if $t < c_s - c_p$, we have that $\hat{x}_{s,p} < 0$, implying that the platform serves all consumers in the market. Profits become

$$\pi_s = 0 \tag{A.47}$$

and

$$\pi_p = f + c_s - c_p, \tag{A.48}$$

respectively.

Suppose instead that $c_s < c_p$. Then, as t decreases below $2u - 2f - c_p - c_s$, $x_{s,\hat{n}o}$ reaches 1 before $\hat{x}_{p2,no}$ reaches 0. In this scenario, consumers in $[0, \hat{x}_{p2,no}]$ are served by the seller and are not contested, consumers in $[\hat{x}_{p2,no}, \hat{x}_{s,p}]$ are contested and served by the seller and consumers in $[\hat{x}_{s,p}, 1]$ are contested and served by the platform. By integrating the prices over the relevant market shares we find

$$\pi_s = -\frac{c_p^2 + 2c_p(c_s + 2f + t - 2u) - c_s^2 + 2c_s t + 2f^2 - 4u(f + t) + 4ft + t^2 + 2u^2}{4t} \tag{A.49}$$

and

$$\pi_p = f\frac{2t(-c_p + c_s + 2f) + (c_p - c_s)^2 + t^2}{4t}, \tag{A.50}$$

respectively. Once $t < u - f - c_p$ we also have that $\hat{x}_{p2,no} < 0$, which results in the same profits as in (A.45) and (A.46). Finally, for $t < c_p - c_s$, $\hat{x}_{s,p} > 1$ and the seller serves the whole market, leading to profits equal to

$$\pi_s = c_p - c_s \tag{A.51}$$

and

$$\pi_p = f, \tag{A.52}$$

respectively.

Step 2. Having found equilibrium profits for both the seller ((A.37), (A.39),(A.41), (A.43), (A.45),(A.47), (A.49) and (A.51)) and the platform ((A.38, (A.40),(A.42), (A.44), (A.46),(A.48), (A.50) and (A.52)) as a function of f and t, we now search for the equilibrium fee f^*.

First, suppose that t is so high that we have partial market coverage, i.e., $t > 2u - f - c_p - c_s$. Platform's profits maximization gives us $f^* = \frac{u-c_s}{2}$, and equilibrium profits are equal to

$$\pi_s^* = \frac{(u-c_s)^2}{8t}$$

and

$$\pi_p^* = \frac{2c_p^2 - 2u(2c_p + c_s) + c_s^2 + 3u^2}{4t},$$

respectively. By replacing f^* in the threshold for partial market coverage, we find that partial market coverage occurs if $t > \frac{3u-c_s-2c_p}{2}$. If t is below this threshold, platform's and seller's profits are as in (A.39) and (A.40), respectively. Platform's profits maximization gives us $f^* = \frac{3u-t-2c_s-c_p}{3}$, resulting in profits

$$\pi_s^* = \frac{(c_p - c_s + t)^2}{18t}$$

and

$$\pi_p^* = \frac{c_p^2 - 2c_p(c_s + 2t) + c_s^2 - 2c_s t - 2t(t - 3u)}{6t},$$

respectively. Repeating the same analysis on the subsequent cases show that they are suboptimal as long as neither the seller nor the platform can profitably serve the whole market by themselves. To find the thresholds of t below which this happens, we compute $\hat{x}_{s,no}$ and $\hat{x}_{p2,no}$ with $f = f^*$, leading to $\hat{x}_{s,no} = \frac{c_p-c_s+t}{3t}$ and $\hat{x}_{p2,no} = \frac{2(c_p-c_s+t)}{3t}$. We thus find that the platform serves the whole market if he is more cost-efficient and $t < c_s - c_p$, whereas the seller covers the whole market if it is more cost-efficient and $t < \frac{c_p-c_s}{2}$.

First, suppose that the platform is more cost-efficient and $t < c_s - c_p$. As the platform can profitably serve all consumers in the market and does not pay the fee f, he has an incentive to raise it in order to reduce the share of contestable consumers. In particular, any $f^* > u - c_s$ ensures that $\hat{x}_{s,no} < 0$, so that the seller cannot contest any consumer and the platform can extract all consumers' utility, leading to profits

$$\pi_s^* = 0$$

and

$$\pi_p^* = u - \frac{t}{2} - c_p,$$

respectively.

Suppose instead that $c_s < c_p$ and $t < \frac{c_p-c_s}{2}$. Then, the seller can serve all consumers in the market and the platform has no incentive to contest them. Then, the platform has the incentive to raise the fee as long as the market remains covered. The last consumer that the seller profitably serves would be the one for who $u - tx - (c_s + f) = 0$. Thus, by setting

$f^* = u - c_s - t$, the platform ensures that the seller serves all consumers in the market, as the last consumer served is the one located in $x = 1$, leading to profits

$$\pi_s^* = t/2$$

and

$$\pi_p^* = u - c_s - t,$$

respectively.

With regards to the seller's equilibrium profits when it is more cost-efficient, note that, for $t < \frac{c_p - c_s}{4}$, its profits under no data-sharing are equal to t, whereas its profits under data-sharing are equal to $\frac{t}{2}$. For $\frac{c_p - c_s}{4} \leq t < \frac{c_p - c_s}{2}$, the seller does not serve the whole market under no data-sharing, but does so under data-sharing. We find that the seller is better off under no data-sharing as long as $t < \frac{1}{23}\left(5\sqrt{2}\sqrt{c_p^2 - 2c_p c_s + c_s^2} + 2c_p - 2c_s\right)$.

Step 3. The analysis in Step 2 has highlighted how, regardless of t, the seller and the platform never compete head-to-head over any consumer. Then, as they are able to extract all available surplus from the consumers they serve, we conclude that consumer surplus is equal to zero for any level of t.

Proof of Proposition 4 To obtain this result, we impose the f^* computed in Proposition 2 in the profit functions described in Proposition 3.

First, suppose that $t \geq \frac{3u - c_s - 2c_p}{2}$. Then, under data-sharing, we have local monopolies and $f^* = \frac{u - c_S}{2}$, which is the same equilibrium fee that is charged under no data-sharing in the local monopolies scenario, which occurs for $t \geq \frac{5u - c_s - 4c_p}{4}$. Thus, we conclude that if $t \geq \frac{3u - c_s - 2c_p}{2}$, maintaining the same equilibrium fee as under the no data-sharing case still results in the local monopolies scenario.

Second, suppose that $\frac{5u - c_s - 4c_p}{4} < t < \frac{3u - c_s - 2c_p}{2}$. In the no data-sharing case, we still have local monopolies, and $f^* = \frac{u - c_s}{2}$. We want to check that, under data-sharing, setting the equilibrium fee equal to the no data-sharing case still results in monopolistic duopoly. As described in the proof of Proposition 3, under data-sharing monopolistic duopoly ensues if $t \geq 2u - 2f - c_p - c_s$, which we can rewrite as $f \geq \frac{2u - t - c_p - c_s}{2}$,i.e., the fee threshold below which hotelling duopoly ensues. We thus need to check that the equilibrium fee $\frac{u - c_s}{2}$ is higher than the threshold fee $\frac{2u - t - c_p - c_s}{2}$ for $\frac{5u - c_s - 4c_p}{4} < t < \frac{3u - c_s - 2c_p}{2}$, which always holdsfor the specified range of t.

Third, suppose that $|c_p - c_s| \leq t \leq \frac{5u - c_s - 4c_p}{4}$. Then, the equilibrium fee under no data-sharing is equal to $f^* = \frac{5u - 2c_p - 3c_s - 2t}{5}$. Like in the former case, we find that this equilibrium fee is always higher than the threshold fee below which Hotelling duopoly ensues for any t in $[|c_p - c_s|, \frac{5u - c_s - 4c_p}{4}]$

Finally, suppose that $t < |c_p - c_s|$. If the platform is more cost-efficient, the equilibrium fee is the same under no data-sharing and under data-sharing, i.e., $f^* = u - c_s$ so that the seller is always inactive and the platform can extract all surplus from consumers.

If instead the seller is more cost-efficient, the equilibrium fee under no data-sharing is always lower than the equilibrium fee under data-sharing. Thus, as the seller pays a lower fee, the seller is better off and the platform is worse off. To check whether this decrease in the equilibrium fee generates competition, it is useful to analyze the location of the last consumer that the platform profitably serves under data-sharing $\hat{x}_{p2,no} = \frac{c_p+f+t-u}{t}$. Once $\hat{x}_{p2,no} > 1$, the platform prefers leaving all consumers to the seller. We can rewrite this condition as $f > u - c_p$. To check that competition does not ensue, we must check that the equilibrium fee under no data-sharing is higher than $u - c_p$ for the desired ranges of t. For $t < \frac{c_p-c_s}{4}$, $f^* = u - 2t - c_s$, which is always higher than $u - c_p$ for the specified range of t. For $\frac{c_p-c_s}{4} \leq t < c_p - c_s$, the equilibrium fee is instead $\frac{5u-2c_p-3c_s-2t}{5}$, which again is higher than $u - c_p$ for the specified range of t. Thus, we conclude that even under the no data-sharing fee, the platform does not have the incentive to compete with the seller if the seller is more cost-efficient and differentiation is low. Then, the seller can extract all surplus from consumers, and consumers remain with zero surplus as in the standard data-sharing case.

Proof of Proposition 5 The proof proceeds in two steps. First, we focus on the agency case without data-sharing. Second we analyze the agency case with data-sharing.

Step 1. If the seller is the only firm active in the market, the location of the last consumer who would buy from it is $\hat{x}_{s,no} = \frac{u-p_s}{t}$, and the seller's profits are $\pi_s = (p_s - c_s - f)\hat{x}_{s,no}$. By maximizing them with respect to p_s, we obtain $p_s^* = \frac{c_s+f+u}{2}$, $\hat{x}^*_{s,no} = \frac{u-f-c_s}{2t}$ $\pi_s^* = \frac{(c_s+f-u)^2}{4t}$ and $\pi_p^* = f\hat{x}^*_{s,no}$. This scenario holds as long as $\hat{x}^*_{s,no} < 1$, which we can rewrite as $t > \frac{u-f-c_s}{2}$.

Below this threshold, the seller can serve all the market. Then, its best strategy is to set its price so that the farthest consumer, located in $x = 1$, is indifferent between buying nd not buying. This results in $p_s^* = u - t$, $\pi_s^* = u - t - c_s - f$ and $\pi_p^* = f$.

Finally, we turn to the platform's profits. If the market is partially covered, the platform maximizes his profits and sets $f^* = \frac{u-c_s}{2}$, obtaining $\pi_p^* = \frac{(c_s-u)^2}{8t}$. Instead, if the market is completely covered, the platform has an incentive to always increase the fee. Then, the maximum fee he can set is the one that binds the total coverage constraint, i.e., $f^* = u - c_s - 2t$. By comparing the profit functions, we find that if $t \leq \frac{u-c_s}{4}$ the platform sets $f^* = u - c_s - 2t$ and the market is fully covered. Else, he sets $f^* = \frac{u-c_s}{2}$ and the market is partially covered. Equilibrium seller's profits are equal to

$$\pi_s^* = \begin{cases} t & \text{for } 0 < t \leq \frac{u-c_s}{4} \\ \frac{(c_s-u)^2}{16t} & \text{for } t > \frac{u-c_s}{4} \end{cases}$$

which are always higher than its profits under the hybrid business model.

With regard to consumer surplus, we obtain it by integrating consumer utility over the served market share:

$$CS^* = \begin{cases} \frac{t}{2} & \text{for } 0 < t \leq \frac{u-c_s}{4} \\ \frac{(c_s-u)^2}{32t} & \text{for } t > \frac{u-c_s}{4} \end{cases}$$

which is higher than the consumer surplus under the hybrid business model.

Step 2. Under data-sharing, the seller can price discriminate and is the only active firm in the market. Then, it offers a price $p_s(x) = u - tx$ and extracts all surplus from consumers. The last consumer it would want to serve is the one for which $p_s(x) = c_s + f$, resulting in $\hat{x}^*_{s,no} = \frac{u-f-c_s}{t}$ Seller's profits are thus equal to the integral of the price over the market share, resulting in $\pi^*_s = \frac{(c_s+f-u)^2}{2t}$. The platform's profits are instead the fee multiplied by the market share, i.e., $\pi^*_p = f\hat{x}^*_{s,no}$. Once $t < u - f - c_s$, $\hat{x}^*_{s,no} > 1$ and the seller serves the whole market. Then, the seller's profits become $\pi^*_s = u - \frac{t}{2} - f - c_s$, and the platform's profits are equal to $\pi^*_p = f$.

If the market is partially covered, the platform maximizes his profits by setting $f^* = \frac{u-c_s}{2}$. However, this results in the market being partially covered only as long as $t < \frac{u-c_s}{2}$. Once t is above this threshold, the platform has an incentive to set the fee so that the market coverage constraint is binding, i.e., $f^* = u - c_s - t$. Equilibrium seller's profits are thus

$$\pi^*_s = \begin{cases} \frac{t}{2} & \text{for } 0 < t \leq \frac{u-c_s}{2} \\ \frac{(c_s-u)^2}{8t} & \text{for } t > \frac{u-c_s}{2} \end{cases}$$

which are higher than the seller's profits under the hybrid business model.

With regards to consumer surplus, it is equal to zero as the seller extracts all surplus from the consumers it serves.

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