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INFORMATION PROVISION IN HYBRID PLATFORMS

May 2023

Marco Fanno Working Papers – 301

Dipartimento di Scienze Economiche e Aziendali 'Marco Fanno'

Università degli Studi di Padova

Information provision in hybrid platforms*

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March 2023

Abstract

We study the incentives of a monopolistic hybrid platform in sharing its superior market information with the third-party seller hosted on its marketplace. After observing platform information-sharing policy, the seller competes in prices with the platform over a horizontally differentiated good. Despite platform duality, an equilibrium in which the platform shares information with the seller occurs. We highlight how the platform has incentives to share information either for relaxing price-competition or for increasing the volume of transactions. Platform incentives to share information are strongest for intermediate degrees of product differentiation. Information provision results in consumer surplus extraction such that the total welfare is reduced. Although entering as a seller and providing market information is profitable, when analysing platform entry as the acquisition of one of the sellers we may observe equilibria in which the platform either sticks to agency or does not provide information since this would increase the entry cost.

Keywords: *hybrid platforms, information provision, data sharing, vertical integration.*
JEL codes: *D42, L12, L41.*

*Presented at the 14^{th} *Paris Conference on Digital Economics*, *Oligo workshop 2023*, *IBEO 2023 (XII workshop on institutions, individual behaviour and economic outcomes)* and *EARIE 2023*.
We thank Heski Bar-Isaac, Paul Belleflamme, David Bounie, Marc Bourreau, Carlo Cambini, Riccardo Camboni, Pierre-Francois Darlas, Alexandre de Cornière, Axel Gautier, Doh-Shin Jeon, Leonardo Madio, Fabio Manenti, Andrea Mantovani, José Luis Moraga-Gonzalez, Georgios Petropoulos, Flavio Pino, Michelangelo Rossi, Luca Sandrini, Robert Somogyi, Guillaume Thébaudin, Mark J. Tremblay, Paola Valbonesi, Nikhil Vellodi, Thibaud Vergé, Patrick Waelbroeck and Yeron Yehezkel for extremely valuable comments.

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1 Introduction

The behavior of online platforms have recently raised the awareness of policymakers and academics alike. A main concern is their hybrid nature: they own and manage a platform — possibly with a large market share — and, at the same time, they compete with third-party firms operating within the same platform. For example, Apple hosts on its App Store third-party streaming services (such as Spotify and Tidal) and, at the same time, offers a competing service (Apple Music). Similarly, Amazon is both a marketplace and a reseller, directly competing with third-party sellers; in many instances, the same products can be sold simultaneously by both Amazon and other sellers.[1] In 2020, although Amazon private labels represented less than 1% of the listings in each product category they were generating up to 9% of the total sales volume in the clothing department and up to 29% in the book department.[2]

In many instances, online platforms act as *gatekeepers*. According to Regulation (EU) 2022/1925 (Digital Markets Act or DMA, hereafter),[3] gatekeepers are platforms that have a significant impact on the internal market, providing a core platform service which is an important gateway for business users to reach end users and enjoy (or might enjoy) an entrenched and durable position.[4] Gatekeepers, therefore, provide a *de facto* essential input, that is a digital infrastructure to which a third-party needs access to be able to have a presence in the market. For instance, advertisers cannot avoid to rely on advertising services provided by Google as more than 90% of searches are made on its search engine[5]. Similarly, in the retail industry, Amazon owns around 60% of total e-commerce sales,[6] which pressures sellers to use Amazon's Marketplace as a way to grow their business and gain visibility. Providing an essential input, gatekeepers have the ability to foreclose third-party firms. Considering their dual nature, might they also have an incentive to do so and under what circumstances? As stressed by the DMA, thanks to extreme scale economies, strong network effects, lock-in effects, the lack of multi-homing and data driven-advantages, the action of gatekeepers in digital markets may substantially impact the fairness of market functioning and firms relationships.

[1] As of 2022, Amazon operates as first party seller (with and without private-label products) in the following product categories: consumer electronics, beauty, home&kitchen, softlines, consumables, books and toys.

[2] Data were reported by Amazon's founder Jeff Bezos in response to House Antitrust Subcommittee questions following the July 29, 2020 hearing.

[3] DMA, which was signed into law by the European Parliament and the Council of the European Union in September 2022 and will become applicable, for the most part, on 2 May 2023, aims at increasing competition in the European digital markets avoiding abuse of market power by large companies.

[4] Article 3.1, DMA.

[5] Nasdaq: https://www.nasdaq.com/articles/2-growth-stocks-to-buy-and-hold-forever-3

[6] PYMNTS: https://www.pymnts.com/news/retail/2022/amazons-share-of-us-ecommerce-sales-hits-all-time-high-of-56-7-in-2021/

In this paper our aim is to study the extent to which online platforms might facilitate the business of third-party sellers providing useful information about market demand. Hybrid platforms, indeed, enjoy a privileged position in several dimensions with respect to the sellers they host. One of these dimensions is the information about market demand which is derived from the data collected on the marketplace. In practice, due to the lack of detailed data, sellers (including both manufacturers and resellers) cannot adequately observe demand information. In contrast, platforms — as the owners of the digital infrastructure — can more easily acquire high-quality and detailed information on demand than sellers, especially when the former serves as an online marketplace. Unlike brick-and-mortar stores, online marketplaces can observe more efficiently detailed information about the market, such as consumer online browsing histories, consumer purchase histories and sales data. These data play an essential role in forecasting demand potential or trends. Furthermore, online marketplaces are more proficient at information analysis because they are usually equipped with advanced information technology and data analytic tools. Hence, sellers may have to rely on online marketplaces for demand information.

Thus, crucial questions arise: what are a platform's incentives to share market information with independent sellers when they compete with each other on the marketplace? How does platform information sharing policy affect firm and consumer surpluses? Anecdotal evidence suggests that sellers massively rely on the hosting platform analytics and recommendations tools for setting their pricing strategies, regardless of the fact that the platform is operating in the same product market (Li and Zheng, 2021). This is the case of small and medium retailers using Amazon's Marketplace, which can access broad market information related to their products through insights provided by Amazon itself. Moreover, brand owners may also subscribe for free to *Amazon Analytics*, an advanced market information provider that the platform offers to its third-party sellers. Other platforms as well (e.g., Google and Apple) provide sophisticated data analytic tools through which sellers can monitor their performance in addition to learning information about competitors and forecasting market trends. Several information provision strategies have been implemented over time. In 2012, Alibaba (i.e., the owner of Tmall) set up Ali Index, an open access data platform to provide all market sellers with detailed research reports on market trends or demand forecasts for many product categories. The emergence of Ali Index indicated that Tmall decided to fully share its demand information with all sellers. Moreover, in 2017, the Tmall Innovation Center (TMIC) was established. As a market-research division of Tmall, the TMIC's goal is to enable sellers to make more informed decisions by providing them with the most accurate demand information. By designing these ancillary services and by controlling the accuracy of the information provided through analytics, platforms actually affect sellers' strategies as well as market outcomes. Hence,

understanding under which conditions hybrid platforms provide accurate information about market demand is essential for regulators and policymakers to better tailor pro-competitive measures.
The DMA has established rules that only gatekeepers will have to comply with.[7] Among these rules, gatekeepers must allow their business users to access the data that they generate in their use of the gatekeeper's platform. In this paper, instead of raw data, we focus on information, namely the content extracted from data and provided to third-party sellers through free analytics tools. As mentioned before, this kind of practice has been widely adopted by platforms way before the DMA proposal. Although this may seem to be aligned with the DMA, our results suggest that sharing market information may have highly undesirable welfare effects.
In our model, a platform hosts the sale of two horizontally differentiated products. One product is always sold by a third-party seller while the other product is either sold by the platform itself (*dual mode*) or sold by a second independent seller (*agency mode*). In addition of deciding which type of business mode to implement, the platform is also in charge of choosing the amount of information to provide to the seller(s). When the platform adopts an agency business mode, the incentives to share market information with third-party sellers are clearly strong, as both agents can achieve higher profits and the platform extracts — through a fee — a portion of them. Under a dual mode, instead, one may think that the intrinsic conflict of interests of such business model prevents the platform from providing good quality information to third-party sellers. It would be reasonable to think that, since the platform is also competing against a third-party seller within its own marketplace, it has incentive to preserve the existing information asymmetry such that it can steal consumers from sellers and *win* the pricing competition game. Surprisingly, full-information sharing occurs in equilibrium despite platform duality because of what we call the *information effect*, which allows both the the platform and the seller to make higher expected gains. We find that platform incentives to share information are strongest for intermediate degrees of product differentiation. Information provision results in expected consumer surplus extraction such that the expected total welfare is reduced.
The remaining sections are organized as follows: Section 2 discusses the literature this paper contributes to. Section 3 presents the theoretical setting. Section 4 illustrates the results of our baseline model. In Section 5 we carry out the welfare analyses while in Section 6 we compare the dual mode with a more traditional agency model. 7 presents an extension where the platform decides whether to operate as a dual or a pure agency platform. Finally, Section 8 concludes and indicates directions for future research.

[7] See Chapter III of the DMA related to practices of gatekeepers that limit contestability or are unfair.

2 Related literature

Our work is related to three main strands of literature. The first one comprises studies of information asymmetry and information sharing. Horizontal information sharing, namely market information exchange between competitors, is at centre of the analysis in many papers. The seminal paper by Gal-Or (1985) investigates the incentives for information sharing among firms in an industry by considering an oligopolistic market where firms face an uncertain demand for their product. Each firm observes a private signal for the state of demand and decides whether to reveal it to other firms and how complete this revelation will be. As a result, no information sharing occurs in equilibrium regardless of the correlation of private signals.

Vives (1984) extends the work of Gal-Or (1985) by: i) allowing for differentiated goods and ii) introducing also Bertrand competition. The author studies a duopoly model where firms have private information about an uncertain linear demand, it is shown that if the goods are substitutes (not) to share information is a dominant strategy for each firm in Bertrand (Cournot) competition. If the goods are complements the result is reversed. Furthermore the market outcome with respect to information sharing may be optimal in Bertrand competition if the products are good substitutes. With complements the market outcome is always optimal.

In line with this work, we show how information-sharing outcomes crucially depend on the degree of product differentiation. Nevertheless, our model significantly departs from the one employed by Vives (1984) by considering one of the two firms to be vertically integrated (i.e. the hybrid platform), which allows us to obtain some of its results in the case of price competition with asymmetric firms. Moreover, unlike Vives (1984), we show that market outcomes can be sub-optimal from a total welfare point of view, regardless of the degree of product differentiation.

Many papers examine information sharing in traditional supply chains where information is vertically exchanged between the upstream and the downstream market. Zhang (2002) considers a supply chain with one manufacturer in the upstream and two competing retailers with private demand information in the downstream. The paper shows that the manufacturer's optimal strategy is independent of the type of downstream competition, Cournot or Bertrand, and that no information will be shared with the manufacturer on a voluntary basis. However, complete information sharing, which benefits all three parties, can be achieved through side payment when the retailers' information is statistically less accurate.

More recently, authors have investigated information sharing in the case in which a platform act as intermediary between firms and consumers. In these papers, the platform has superior information about market demand. Tsunoda and Zennyo (2021) examine a model in which a supplier sells products through an online platform and an offline retailer under conditions of demand uncertainty. The actual demand potential can be observed by the platform and retailer, but not by the supplier. However, the platform can commit to sharing its demand information with the supplier. Results show that the platform charges its commission rate so that the supplier chooses the agency model rather than the wholesale one, unless the consumer demand is sufficiently uncertain. Nevertheless, information transparency arising from the platform's voluntary information disclosure can be unfavorable to the retailer.

Liu et al. (2021) find that a platform that operates in agency mode has incentives to share the information, and such sharing is beneficial both to the platform and to all sellers. Under the asymmetric information sharing format, the optimal strategy for the platform is to select a subgroup of sellers and truthfully share information with them. Under the symmetric sharing format, the platform must share the same information with all sellers and thus has incentives to reduce the accuracy of the shared information. With our work we will show that some of the results in Liu et al. (2021) hold also when the platform operates in dual mode.

Li and Zheng (2021) instead consider co-opetition between a manufacturer and a retailer on an online marketplace. Their analysis shows that when the intensity of competition between the manufacturer and reseller is relatively low and demand variability is moderate, the online marketplace prefers full information sharing; otherwise, it prefers to share its demand information only with the manufacturer. Moreover, they find that the manufacturer always prefers the scenario with full information sharing to the scenario that endows her with an informational advantage over the reseller. When, as in Kirpalani and Philippon (2020), consumers are the ones sharing data with the platform (which then sells them to firms), data sharing increases gains from trade by improving match quality but gives more market power to the platform relative to the merchants which can reduce entry and consequently consumer welfare. This leads to an externality not internalized by consumers thus leading to more data sharing than is efficient. We depart from these works by investigating the hybrid role of the platform which adds a layer of complexity in understanding the effects of information sharing. Indeed the information value affects profits from direct sales and from intermediation in different ways such that the overall effect can be hard to predict. Our model allows us also to investigate the platform entry in a given product market and the optimal information policy before and after the entry.

A second strand of literature is the one on hybrid platforms and platform duality. Both the empirical and theoretical literature have not found conclusive evidence of the effects of platform entry in competition with third parties on economic outcomes. For example, Wen and Zhu (2019) studied how Android app developers which are more vulnerable to the entry threat of Google reduced their innovation effort, increased their app prices, and eventually shifted their effort to new or unaffected markets. Zhu and Liu (2018) studied the entry of Amazon into the product space of third-party sellers, finding that sellers pull their products from the marketplace.

Other empirical studies have, instead, highlighted some positive effects. For example, Foerderer et al. (2018) found that the decision of Google to release Google Photos in 2015 and enter the market of all-purpose apps for organizing, editing, and sharing digital photographs, spurred major updates from existing apps.

The theoretical literature found an ambiguous response too. Some studies found that platform entry in competition with third parties have pro-competitive effects. For example, Hagiu et al. (2022) found that platform duality might be welfare-enhancing because of its pro-competitive effect, helping consumers to save shopping costs and limiting third parties' pricing. In turn, an outright ban on platform duality could be harmful to consumers. Similar pro-competitive effects are documented by Dryden et al. (2020) and Etro (2021), but the entry decision depends on its category-specific cost-advantage compared to third-party sellers and the type of fee strategy implemented. These positive effects should be balanced against the negative effects, such as foreclosure or reduction in product variety. For example, Padilla et al. (2020) considered a dynamic framework to understand the incentive of a platform to abuse its gatekeeper role by privileging its own products. They found that the incentive to foreclose third parties arise when the gatekeepers face saturated demand and this may be detrimental to consumers.

Anderson and Bedre-Defolie (2021) focused on the decision of a platform to act as a reseller or be 'hybrid', competing therefore with third-party sellers. They found that a hybrid model might lead to a reduction in consumer surplus when the platform's quality increases. This effect arises because the platform increases commission fees, so reducing seller participation and, hence, hurting consumers. Firms may also face a hold-up problem when dealing with a hybrid platforms as sellers fear that they cannot recoup their sunk costs of entry, they do not join the platform. Muthers and Wismer (2013) find that a proportional fee may mitigate the problem, unlike classical two-part tariffs.

Our work complements this strand of literature by focusing also on the role of the platform as information gatekeeper such that it is able to provide or restrict the access to an essential input as market information. We show how information provision policies heavily affect pricing strategies and final outcomes. The existing literature has shown how gatekeeping platforms can use limited access to the marketplace and the fee imposed on sales and revenues as tools for reducing the competitive pressure on the platform itself intended as a selling agent. We show that information provision, even when it is verifiable (hence truthful), can be just another viable option for relaxing

competition despite being profitable also for third-party sellers.
The third stream of literature which connects to our work is the one on vertical integration, access pricing and sabotage. The question of how a monopolist owner of a bottleneck facility should set the quality of the facility and the price for access to the facility by an entrant or rival supplier of a complementary component continues to be an interesting question for theory and policy. This question is often framed in the antitrust context of an unregulated "essential facility" monopolist that is vertically integrated into a complementary upstream or downstream activity in which one or more other producers are present (or may enter). In our case, the essential facility is the marketplace which is necessary to the third-party seller for reaching customers. The level of market information provided to sellers by the platform can be considered instead as the "quality" of the essential facility. We can then talk about "sabotage" anytime the platform decides not to disclose market information to third-party sellers.
Economides (1998) finds that a monopolist in the essential input market has an incentive to practice non-price discrimination against its downstream rivals, sabotaging the monopolized product until they are driven out of business. Beard (2001) argue strongly in favor of this point of view, and present a model demonstrating the incentive of a regulated dominant firm to engage in anti-competitive “sabotage” against downstream rivals.
Contrary to these works, we find that the essential input monopolist does not have incentives in sabotaging the facility provided to third-party sellers as the expected gains from information provision are positive.

3 Baseline framework

We consider a platform operating as a monopolist, P, and a representative consumer. The platform operates in dual mode, namely it provides a marketplace to third-party sellers for reaching consumers while it operates at the same time as first-party seller competing in price against other firms. For tractability we consider in our analysis a single representative third-party seller, S, hosted on the marketplace.

3.1 Market demand

The seller and the platform compete in prices on the retail market offering differentiated products. We model competition using the demand specification used by Shubik and Levitan (1980) which is derived by considering the following consumer utility function:

$$U = v(q_i + q_j) - \frac{1}{2}(q_i + q_j)^2 - \frac{(q_i - q_j)^2}{2(1+\mu)} - p_i q_i - p_j q_j \quad \forall i, j \in S, P.$$

where v indicates the maximum willingness-to-pay and $\mu \in [0, +\infty)$ is a parameter representing product differentiation. When the representative consumer maximizes his utility with respect to quantities it is possible to rearrange the solution in terms of own direct market demand:

$$q_i = \frac{1}{2}\left(v - \left(1 + \frac{\mu}{2}\right) p_i + \frac{\mu}{2} p_j\right) \quad \forall i, j \in S, P.$$

In order to simplify the analysis we apply the reparametrization $\mu \to \frac{2\gamma}{1-\gamma}$ with $\gamma \in [0, 1)$ such that the higher γ the greater the substitutability between products. In this way we obtain the following demand specification:

$$q_i = \frac{1}{2}\left(v - p_i + \frac{\gamma}{1-\gamma}(p_j - p_i)\right) \quad \forall i, j \in S, P.$$

v, can be either high or low. In particular, $v = \bar{v}$ when a high demand state is realized and $v = \underline{v}$ for a low demand state, with $\bar{v} > \underline{v} > 0$. This parameter determines the maximum willingness to pay of the consumer and consequently the demand function. We indicate with $\delta \in (0, 1)$ the probability that high demand is realized; this information is common knowledge. The platform always observes the true state of demand once realized while the seller does not. As illustrated in section 2 or in the case of Tmall and its choice to create a market-research division (i.e., Tmall Innovation Center), providing information is a long-term investment which characterizes the business of the platform for future periods, thus we assume that the platform decides whether to share information with the seller before demand potential is realized. When the platform decides not to share market information, seller's posterior distribution coincides with the prior one. It follows that when information is not shared, the seller decides the price of its product on the expected demand potential $v^e = \delta\bar{v} + (1 - \delta)\underline{v}$. Demand is ex-post verifiable by the seller, hence the platform cannot provide false information.
Finally, it is worth noticing that this demand specification does not make the intercept to vary with product differentiation. In other words, changes in the differentiation parameter do not lead to any variety effect such that there is no market expansion.

3.2 Firms

We consider a representative seller which sets its price for maximizing the following objective function:

$$\pi = \frac{1}{2}[p_s(1-f) - c_s]\left[v - p_s + \frac{\gamma}{1-\gamma}(p_p - p_s)\right]$$

which depends on the information about the demand potential v. If information is shared, the seller perfectly knows market demand and correctly sets its price. All things equal, a higher demand potential pushes the seller to set higher prices. When the degree of product differentiation decreases (i.e. γ increases) the elasticity of demand with respect to the price difference $(p_p - p_s)$ increases as well as price competition. In case the platform does not share information, the seller maximizes its expected profit according to the expected demand potential v^e.[8] The seller has to pay a share f of its revenues to the platform on every transaction it makes while its marginal cost of production is c_s and it take values in the unit interval.

3.3 Platform

The platform instead always observes the actual demand state and competes in prices with the seller for maximizing:

$$\Pi = \frac{1}{2}\left(fp_s\left(v - p_s + \frac{\gamma}{1-\gamma}(p_p - p_s)\right) + (p_p - c_p)\left(v - p_p + \frac{\gamma}{1-\gamma}(p_s - p_p)\right)\right)$$

where the first term is the share f of the seller's revenues earned by hosting the third-party seller and while the second term is the stream of profits generated by selling directly the product as a reseller. The platform has a marginal cost of production c_p which takes values in the unit interval. For tractability purposes, we consider marginal costs to be lower than the consumer willingness-to-pay. We are also assuming that providing information has not extra costs. In line with most of the existing literature, the platform imposes an ad-valorem revenue sharing fee f which is exogenously determined.[9]

[8] When information is not shared, the seller incorporates into its response function the expected price of the platform, namely the price that the platform would set considering $v = v^e$. It is then impossible for the seller to infer the actual demand state through the price of the platform without information provision. See appendix A.1.

[9] The profit of the platform with information provision dominates the profit without information for every value of the revenue sharing fee. Moreover, simulations points to the fact that the optimal revenue sharing fee is the same with and without information provision. These facts allow us to claim that our results would hold also in the case of an endogenously determined fee.

3.4 Timing

The timing of the extensive-form game is the following:

1. The platform decides whether to share information.
2. Market demand potential is realized and observed by the platform.
3. The seller receives information, if any, then price competition takes place and profits are realized.

4 Analysis

4.1 Price competition

Whenever information is not shared, the seller sets its price according to the expected demand potential v^e. Since the seller's price is proportional to the demand potential, the uninformed seller always sets a sub-optimal price $p_s(v^e) \in (p_s(\underline{v}), p_s(\bar{v}))$. Indeed, when the realized demand potential is high (low) the uninformed seller sets a price lower (higher) than optimal such that it earns a sub-optimal profit.

Lemma 1. *When the platform does not share information, the seller sets a different price from the profit-maximizing one.*

Sharing market information does not only affect the profit of the seller but it changes the price competition outcome in its entirety, including the platform's expected profit. In order to see how pricing strategies are affected by the information sharing policies. Consider the difference between the price of the seller and the one of the platform when information is shared:

$$\Delta P^I = p_s^I - p_p^I = \frac{c_p(1-f)(2-\gamma) + (1-f)fv(1-\gamma)\gamma + c_s(\gamma + f\gamma - 2)}{(1-f)((1+f)\gamma^2 - 4)}$$

with $v \in \{\underline{v}, \bar{v}\}$.[10] This price difference is increasing in c_s and f while it decreases with c_p. Indeed in line with the literature, an increase in one firm's marginal cost makes other firms in the same market relatively more competitive. The price difference when information is not shared can be

[10] Equilibrium prices for both the platform and the seller, with and without information sharing, are shown in appendix A.1.

rewritten in terms of the price difference under information sharing

$$\Delta P^N = p_s^N - p_p^N = \Delta P^I - \frac{(v - v^e)(2 - \gamma - \gamma^2)(2 - \gamma - f\gamma)}{8 - 2(1 + f)\gamma^2}. \tag{1}$$

Since both f and γ lie in the unit interval, the sign of the second element in equation (1) depends entirely on $v - v^e$, namely the difference between the realized demand state and the expected one. When the demand state is high, $v - v^e > 0$, the price difference is lower than the information sharing case ($\Delta P^N < \Delta P^I$) since the seller expects a lower demand and sets a lower price. The opposite occurs when the realized demand state is low. Price differences cancel out the more we move towards the homogeneous goods case: $\Delta P^N = \Delta P^I$ as $\gamma \to 1$, prices do not depend on demand potential and are set in relation of marginal costs only.

Following Lemma 1, the profit of the platform coming from intermediation is always maximized when information is shared given that: i) the seller earns higher profit and revenues with information sharing and ii) the platform is imposing a revenue sharing fee.

The profit of the platform coming from sales instead increases with the price difference ΔP and the other way around. For instance, if the realized demand is low the uninformed seller sets a higher price than the optimal one (increasing the difference between the price of the seller and the price of the platform), this relaxes competition such that the platform makes more profits by stealing customers from the seller. On the contrary, if the realized demand is high, the uninformed seller sets a lower price than the optimal one (reducing ΔP) and results to be too aggressive for the platform which is forced to set lower prices thus losing profits.

4.2 Information sharing policy

When the platform decides to share market information with the seller, it earns a profit of $\Pi^I(\overline{\mathbf{p}}^I(\bar{v}, \bar{v}))$ when the demand is high and a profit of $\Pi^I(\underline{\mathbf{p}}^I(\underline{v}, \underline{v}))$ when the realized demand is low. When information is not shared instead, the platform earns $\Pi^N(\overline{\mathbf{p}}^N(\bar{v}, v^e))$ and $\Pi^N(\underline{\mathbf{p}}^N(\underline{v}, v^e))$ when market demand is high and low, respectively. [11]Notice that $\overline{\mathbf{p}}^N(\bar{v}, v^e)$ is the price vector given that market demand is high ($\bar{v}$) and the seller does not have demand information such that it bases its strategies on v^e; the other three price vectors are defined accordingly.

In this part of the paper, we consider the case in which the platform is not able to promptly adjust its information sharing policy to market demand shocks. Hence, it is like assuming that the platform commits to its information sharing policy without having the possibility to report false

[11]Platform's profits in each of the four demand-information combination are shown in appendix A.3.

information. In line with Li and Zheng (2021), the information sharing policy is determined before market demand is realized, thus the platform has to weigh the gains and losses from information sharing for the probability that a given demand state is realized. Information sharing occurs in equilibrium if the expected profit with information sharing is larger or equal than the expected profit without information sharing, formally:

$$\delta\Pi^I(\overline{\mathbf{p}}^I(\bar{v},\bar{v})) + (1-\delta)\Pi^I(\underline{\mathbf{p}}^I(\underline{v},\underline{v})) \geq \delta\Pi^N(\overline{\mathbf{p}}^N(\bar{v},v^e)) + (1-\delta)\Pi^N(\underline{\mathbf{p}}^N(\underline{v},v^e)). \tag{2}$$

In order to understand what this choice entails, let us first consider the difference between the expected profits of the seller with information sharing and the expected profits of the seller without information sharing, formally defined as:

$$\Delta\pi^e = \pi_I^e - \pi_N^e = \frac{2(\bar{v}-\underline{v})^2(1-f)(1-\gamma)(2+\gamma)^2(1-\delta)\delta}{2((1+f)\gamma^2-4)^2} \geq 0.$$

The seller's expected profit difference $\Delta\pi^e$ is non-negative and strictly decreasing in the product differentiation when $\gamma \in (0,1)$. This means that the third-party seller always benefit in expected terms from information sharing and that this expected gain shrinks as product differentiation decreases. When products are homogeneous, the platform and the seller set prices equal to marginal costs regardless of the information-sharing policy such that $\Delta\pi^e(\gamma \to 1) = 0$.

Lemma 2. *The expected variation of the third-party seller's profit after information sharing is always non-negative.*

Part of the expected additional profit of the platform when information is shared consists in the seller's additional revenue that the platform is able to extract through its revenue sharing fee. Given Lemma 2, the expected intermediation profit of the platform is always non-negative as well.

Lemma 3. *Information sharing always weakly increases the profits of the platform as intermediary.*

As stated in Lemma 3, intermediation profits clearly increase with information sharing: it is interesting to understand why expected sales profits increase as well even though the platform loses its information advantage.

Since we are investigating the case of a hybrid platform, the platform and the seller may also compete in prices for customer sales against each other. When this occurs (i.e., products are not independent), the platform and the seller's pricing strategies are influencing each other, such that if the seller sets prices inefficiently the platform on average sets an inefficient price as well. This implies that also the price of the platform changes according to the information-sharing policy. Indeed, as mentioned in Lemma 1, the uninformed seller sets a higher (lower) price than optimal if realized market demand is low (high); when this occurs, the platform's best response is to increase (decrease) its price as well. In particular, when the uninformed seller sets a higher than optimal price, competition is relaxed and the platform has the opportunity to make higher profits by increasing its price as well. In the opposite scenario, instead, the uninformed seller is more aggressive, forcing the platform to set a lower price as well in order not to lose customer sales and to minimize its loss.

Lemma 4. *The information-sharing gains of the platform made with a high realized demand outweigh information-sharing losses with a low realized demand.*[12]

By taking the difference between the left-hand side and the right-hand-side in expression (2), we obtain the platform expected profit difference between the two information sharing policies (sharing and not sharing), formally defined as:

$$\Delta\Pi^e = \frac{(\bar{v} - \underline{v})^2(2+\gamma)(1-\gamma)((1+f)^2\gamma^3 - 8f - 4(2+f)\gamma + 2(f^2-1)\gamma^2)(1-\delta)\delta}{8((1+f)\gamma^2 - 4)^2} \geq 0.$$

The function $\Delta\Pi^e$ does not depend on marginal costs, it is increasing in the variation of potential demand $(\bar{v} - \underline{v})$ and it is concave in the degree of product differentiation. The expected profit difference can be interpreted as a measure of the platform incentives to share information with the seller. Given Lemmas 3 and 4, this difference is always non-negative, hence the hybrid platform has, in expected terms, always incentive to share information.

Proposition 1. *A hybrid platform, which commits to its information sharing policy before market demand is realized, has always the incentive to share market information with downstream sellers hosted on its marketplace.*

Contrarily to results in Economides (1998), Proposition 1 states that an input provider monopolist has not the incentive to *sabotage* its downstream competitor. This also shows that some of the results obtained in the seminal work of Vives (1984) hold when one of the two downstream firms is vertically integrated upstream.

The net expected variation in platform's profits can be explained as the result of an *information effect* taking place between the pricing strategies of the platform and the seller. When goods are substitutes, reducing uncertainty on the common market demand reduces (increases) the price

[12] See proof in Appendix A.4

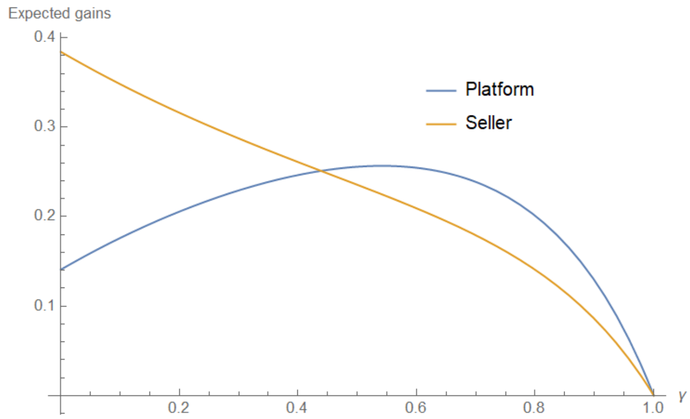

Figure 1: Platform expected gains on degrees of product differentiation

level in high (low) demand state, hence increasing the expected market power of both parties. The more the goods are substitutable (higher γ) the more information-sharing affects pricing strategies and the price level.

The net expected variation is concave in γ such that it takes the maximum value when products are mildly differentiated.

Proposition 2. *The hybrid platform's incentive to share information with the third-party seller is strongest for intermediate degrees of product differentiation.*

Proposition 2 is based on the concavity of the function $\Delta\Pi^e$ with respect to γ. This concavity is the result of the co-existence of an *information effect* and of a *competition effect*. As shown in Figure 1, the former dominates the latter when products are still sufficiently differentiated such that $\Delta\Pi^e$ increases with γ. Nevertheless, when γ is higher than a certain threshold the *competition effect* gets stronger and outweighs the *information effect* such that the extra profits from information are dissipated by fiercer price competition as product differentiation reduces.[13] An intermediate value of γ allows the platform to balance the two effects, maximizing the expected gains from information sharing.

[13]If we consider an endogenous fee, the platform may prefer increasing the fee in order to relax price competition when γ approaches 1. In other words, when goods are similar, the platform may replace its information sharing strategy with an increase in the revenue sharing fee for increasing the average price of the downstream competitor.

5 Welfare analysis

We compute consumer surplus by plugging equilibrium quantities into consumer net utility function:

$$U = v(q_s + q_p) - \frac{1}{2}(q_s + q_p)^2 - \frac{(1-\gamma)(q_s - q_p)^2}{2(1+\gamma)} - p_s q_s - p_p q_p.$$

We compute the difference in terms of expected consumer surplus between the two information sharing policies:

$$\Delta CS^e = CS_I^e - CS_N^e = \frac{(\bar{v} - \underline{v})^2(1-\gamma)(2+\gamma)(2+\gamma+f\gamma)(-12+2(f-2)\gamma+3(1+f)\gamma^2)(1-\delta)\delta}{16((1+f)\gamma^2-4)^2} \tag{3}$$

which is increasing and convex in γ within the unit interval and it is always negative. As we have shown in Lemmas 2 and 4, the profits of both the platform and the seller increase after information sharing when the realized demand is high is larger in absolute value than the profit loss when demand is low. We can say then that information sharing leads to a negative expected consumer surplus.

Market information sharing has ambiguous effects on total welfare; in our total welfare analysis we employ an utilitarian welfare function defined as the sum of consumer surplus and the profit of both platform and seller. The difference between the two expected policy outcomes is:

$$\Delta TW^e = TW_I^e - TW_N^e = \frac{(\bar{v} - \underline{v})^2(1-\gamma)(2+\gamma)(2+\gamma+f\gamma)(-4+\gamma(4+f(-2+\gamma)+\gamma))(1-\delta)\delta}{16((1+f)\gamma^2-4)^2}. \tag{4}$$

Proposition 3. *Information sharing always makes consumers weakly worse off and the utilitarian total welfare decreases unless goods are close substitutes.*

Although information sharing makes both the platform and the seller better off, consumer surplus extraction is large enough to drive total welfare down. Only for very high values of γ the effect of information provision on total welfare is positive. Nevertheless, when $\gamma \to 1$ prices equal marginal costs regardless of the realized demand and $\Delta TW^e = 0$.

Market information can be a tool for foreclosing competitors, the fear is that by not providing market information the platform increases its market power and harms both sellers and consumers. Contrary to what one may think, we show that more information makes sellers (i.e., platform's competitors) better off, yet it harms consumers. When the platform shares market information with the seller, it enjoys an *information effect* that on average increases the price level and reduces consumer surplus. This result suggests that policymakers, before pressuring gatekeepers to share information, should take into account undesirable effects as well. According to our model, as long as information helps sellers in adjusting their pricing strategies, information sharing is detrimental for both consumer surplus and total welfare and should be prevented.

6 Agency vs Dual mode

Platform duality has raised several concerns over the years especially because of the pervasiveness and the extreme network effects enjoyed by online platforms. Vertical integration between upstream and downstream activities (marketplaces and resellers) may be harmful as stressed in popular streams of literature about *access pricing* and *vertical mergers* such as raising costs (in this framework, the revenue sharing fee) or non-price discrimination as sabotaging an essential input for the downstream rival. In our case, the latter takes place by not sharing market information, thus providing a lower quality service to third-party sellers such that competition is hampered and consumers are harmed. One of the proposed remedies is to prevent vertical integration (i.e., dual mode) to occur, thus pushing for either an agency or a wholesale business model. For these reasons we think it is extremely interesting and useful to compare the incentives to share information, and the related effects on major aggregate values, across different business models.

In this part of the paper, we consider a platform that operates as intermediary only (agency mode) and study the optimal information policy and its impact on agents. Under agency mode, there are two third-party sellers in the marketplace, namely s_1 and s_2, competing in prices over a horizontally differentiated good. The timing of the extensive-form game is unchanged: the platform sets its information-sharing policy and the revenue-sharing fee f before market demand is realized, then price competition between third-party sellers takes place.

Coherently with the previous model, we consider a representative consumer with a utility function in the vein of Shubik and Levitan (1980). Therefore, seller s_i sets the price p_{s_i} in order to maximize the following profit function:

$$\pi_{s_i} = \frac{1}{2}(p_{s_i}(1-f) - c_{s_i})\left(v - p_{s_i} + \frac{\gamma}{1-\gamma}(p_{s_{-i}} - p_{s_i})\right)$$

where retailers' prices are function of the demand state $v \in \{\underline{v}, v^e, \bar{v}\}$; while the profit of the platform when it adopts the agency business model has the following form:

$$\Pi^A = f\left(\frac{1}{2}\left(v - p_{s_1} + \frac{\gamma}{1-\gamma}(p_{s_2} - p_{s_1})\right) + \frac{1}{2}\left(v - p_{s_2} + \frac{\gamma}{1-\gamma}(p_{s_1} - p_{s_2})\right)\right)$$

Now, differently with respect to the hybrid model case, there is a symmetric competition between sellers since, under agency mode, both are either informed or not about market demand. Sellers' equilibrium prices without information sharing are:

$$p_A^N = (\underline{v}(1-\delta) + \bar{v}\delta)\left(1 - \frac{1}{2-\gamma}\right) + \frac{c_s}{(1-f)(2-\gamma)}$$

while sellers' prices with information sharing are:

$$p_A^I = v\left(1 - \frac{1}{2-\gamma}\right) + \frac{c_s}{(1-f)(2-\gamma)}.$$

Given equilibrium outcomes of the pricing stage, we can compute the expected increase in each seller's profit due to information provision, formally:[14]

$$\Delta\pi_A^e = \frac{(1-f)(\bar{v}-\underline{v})^2(1-\gamma)(1-\delta)\delta}{2(2-\gamma)^2} \geq 0.$$

Lemma 5. *With an agency business model, third-party sellers are always weakly better off in expected terms after information sharing.*

given Lemma 5, the platform which intermediates trades between sellers and consumers is better off as well since its expected gains are proportional to the revenue-sharing fee:[15]

$$\Delta\Pi_A^e = \frac{f(\bar{v}-\underline{v})^2(1-\gamma)(1-\delta)\delta}{2(2-\gamma)^2} \geq 0.$$

Lemma 6. *With an agency business model, the platform is always weakly better off in expected terms after information sharing.*

We combine Proposition 1 and Lemma 6 in the plot in Figure 2, which shows the combination of product differentiation γ and revenue-sharing fee f which ensures that the incentives to share market information with third-party sellers are higher in dual mode than in agency. In other words, the light blue area in Figure 2 is the set of $\{\gamma, f\}$ combinations such that $\Delta\Pi_{DM}^e > \Delta\Pi_A^e$.

Proposition 4. *Incentives to share market information are larger under agency mode unless goods are close substitutes and the revenue sharing fee is small enough.*

[14]See the equilibrium profits of the sellers with and without information in Appendix A.6

[15]See the equilibrium profits of the platform with and without information in Appendix A.7

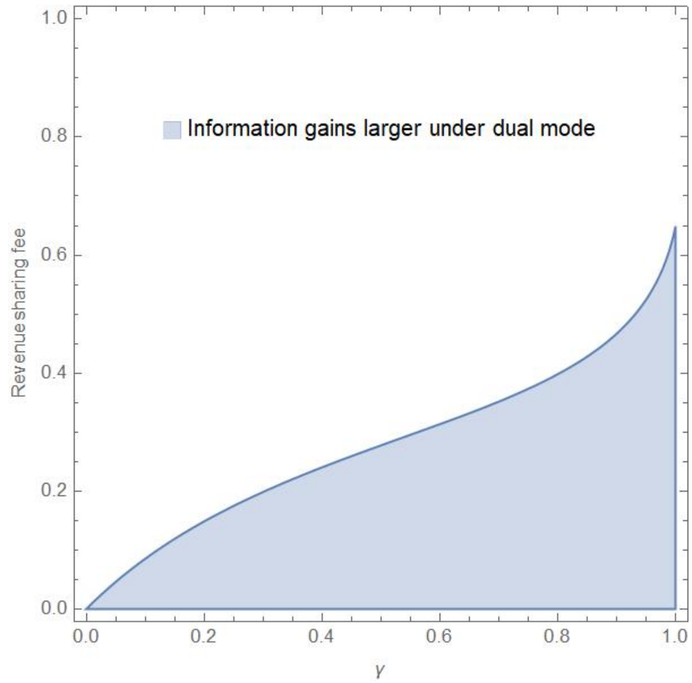

Figure 2: Combinations of revenue sharing fee and product differentiation which provide higher gains under dual mode than under agency

When product differentiation decreases, the platform can use the *information effect* of the information sharing under dual mode for relaxing competition; hence if the revenue-sharing fee is small enough (i.e. intermediation profits are low) the expected gains from information provision are larger for a hybrid platform.

Given Proposition 4, we observe that consumer surplus shrinks in expected terms after market information is shared with an agency business model. Formally:

$$\Delta CS_A^e = \frac{(\bar{v} - \underline{v})^2 (1-\gamma)(3-\gamma)(\delta - 1)\delta}{2(2-\gamma)^2} \leq 0 \tag{5}$$

consumer willingness-to-pay is better targeted by sellers which can extract more surplus such that also the total utilitarian welfare is always non-positive under agency, formally:

$$\Delta TW_A^e = \frac{(\bar{v} - \underline{v})^2 (1-\gamma)^2 (\delta - 1)\delta}{2(2-\gamma)^2} \leq 0. \tag{6}$$

Proposition 5. *Information provision reduces both consumer surplus and total welfare in expected terms. This reduction is larger under agency than under dual mode. Nevertheless, both consumer surplus and total welfare are highest under agency without information provision and lowest under* *dual mode with information provision.*[16]

The intuition for these results is that prices can increase for two reasons: higher fees and platform entry. In particular, as pointed out in Etro, 2021, a hybrid platform has more incentives to raise the price since it can recoup part of the lost profit through the revenue-sharing fee.[17] Therefore, prices are already higher with dual mode than with agency such that information sharing has a larger impact on uninformed third-party sellers. Consequently, when market information is shared by a hybrid platform, the effects of platform entry and information sharing sum together, further reducing consumer surplus.

7 Platform entry decision

After having compared the two business modes, we want to extend the analysis to a more dynamic framework, thus we want to investigate the platform decision to enter in the product space of one of the sellers hosted on its marketplace. As highlighted in several reports, one of the main concerns of competition authorities deals with the possibility of the platform of exploiting its superior market demand information for entering in product markets and hampering competition within the marketplace. Once inside the product space, the platform may have a strong incentives to foreclose its rival by raising the fee, which would also lead to higher retail prices.

We investigate this case study by introducing an additional stage to the extensive-form game employed in the previous sections in which the platform, after setting its information-sharing policy, decides whether to enter the market, adopting a dual mode. This new timing captures the fact that when platforms decide whether and how to provide market information they incur in investments that may be more or less binding compared to their ability to enter a given product market. As in the case of Tmall and its choice to create a market-research division (i.e., Tmall Innovation Center), providing information is a long-term investment which constrains the business of the platform for future periods. [18]

In our model, entering the product space consists in the platform acquiring one of the two retailers and competing with the other one. The cost of the acquisition is equal to the profit that the firm makes under agency. The platform makes a *take-it-or-leave-it* offer to one of the firms when entering the market.

The timing of the new extensive-form game is the following:

[16] See consumer surplus with an agency business model in Appendix A.8

[17] See equilibrium prices with platform entry in Appendix A.1.

[18] We investigate market outcomes with an alternative timing in Appendix A.9.

1. The platform sets the information-sharing policy.
2. The platform decides whether to enter or not.
3. Market demand potential is realized and observed by the platform.
4. The seller receives information if any, then price competition takes place and profits are realized.

In this game, the platform decides the information policy first and then its business model (entry decision). Entry is profitable if the expected dual mode profit, net of the acquisition cost, is larger than the expected profit under agency, formally:

$$\Pi^e - \pi^e > \Pi^e_A.$$

When the platform shares market information, the expected dual mode profit of the platform is higher ($\Pi^e_I > \Pi^e_N$) but the expected profit of the seller is higher as well ($\pi^e_I > \pi^e_N$). In other words, information provision increases also the cost of the acquisition and makes, all things equal, entry less profitable.
We know from Lemma 6 that the platform will always share market information if entry is not profitable (i.e. with the platform operating in agency).
Hence, entry takes place if:

$$max\{\Pi^e_I - \pi^e_I, \Pi^e_N - \pi^e_N\} > \Pi^e_{I_A}$$

while information is not shared in equilibrium if

$$\Pi^e_N - \pi^e_N > max\{\Pi^e_I - \pi^e_I, \Pi^e_{I_A}\}$$

it follows that if $\Pi^e_I - \pi^e_I$ is the highest profit level in the subgame, both entry and information sharing occur in equilibrium.[19]

Proposition 6. *In the unique equilibrium of the game, the platform enters the market either when it is very cost efficient with respect to the seller or when products are very similar. With the agency mode, the platform finds optimal to provide market information while platform entry always occurs without information provision.*

Although the platform is always better off by providing market information, this increases also the profit of the seller thus making the acquisition more costly for the platform. Entry occurs either

[19]See profit functions for both the platform and the seller in Appendix.

when the platform is more efficient than the third-party seller in producing and selling the product ($c_p < c_s$) or when products are perceived as close substitutes (low values of γ). In the latter case, the competitive advantage of the platform lies in the presence of the fee, which increases seller's price, such that the platform is able to make profits from sales despite the little product differentiation.

According to our model, when the platform operates under agency it also provides market information while when it operates in dual mode it does not. Therefore in this game, the platform earns $max\{\Pi_N^e - \pi_N^e, \Pi_{I_A}^e\}$ in equilibrium; which of the two outcomes occurs depends on parameters' values. This shows that the platform can share market information in equilibrium also when entry is taken into account. As we have seen, information sharing results, in expected terms, in higher profits for both the platform and the seller but lower consumer surplus and total welfare. Contrary to Vives (1984), we show that the market outcome can be always detrimental from a total welfare standpoint, regardless of the degree of competition.

8 Conclusion

Nowadays, online platforms often adopt a so-called dual mode, namely a business model where they act both as intermediaries (owning the platform itself) and resellers within their own marketplace, directly competing with third-party sellers. This has raised concerns of competition authorities all around the world since platforms may use their position to favour their sales, thus hampering competition — especially when they act as gatekeepers, enjoying a sizable market share and large network effects. Online platforms can achieve this by deciding how much information about market demand share with sellers. In other words, platforms' decision on whether or not sharing superior market information affects pricing strategies of all the sellers that consider this information relevant for their business.

In this paper we investigate the incentive of a hybrid platform to commit to information sharing when information is verifiable by sellers in order to understand the impact of this strategy on consumer surplus and total welfare. Surprisingly, we find that platforms have strong incentives to share full information with sellers despite the dual mode because of the *information effect* it generates. The *information effect* increases when interactions between the platform and the firm are stronger (i.e., goods are closer substitutes) but starts decreasing when product differentiation is too small, thus incentives to share information are strongest for intermediate degrees of product differentiation. Information provision results on average in more surplus extraction by firms and platforms, thus it lowers both consumer surplus and total welfare.

We also find that the agency mode without information provision is the best scenario for consumers while dual mode with informed sellers is the worst one. Nevertheless, both the expected consumer surplus and total welfare decrease after information provision more under agency than in the dual mode case.

When the platform's entry decision is taken into account, the platform enters the product space of the third-party seller either when its cost is very low or when products are very similar. Since information provision increases the cost of the acquisition, the equilibrium strategy of the platform is either to operate in agency providing market information or to operate in dual-mode without information provision. Platform entry tends to increase the average price level either through information provision or through higher fees, thus reducing consumer surplus.

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Appendix

A Technical appendix for Section 4

A.1 Equilibrium prices

Equilibrium prices are obtained by solving the system of first order conditions. The platform can always observe the demand realization such that its best response is defined as

$$p_p(v, p_s) = \frac{1}{2}(v(1-\gamma) + c_p + (1+f)p_s\gamma), \quad v \in \{\underline{v}, \bar{v}\}. \tag{7}$$

When the platform shares information with the seller, the best response of the seller takes the following form:

$$p_s(v, p_p) = \frac{1}{2}\left(v(1-\gamma) + \frac{c_s}{1-f} + p_p\gamma\right), \quad v \in \{\underline{v}, \bar{v}\}. \tag{8}$$

By solving the system of best responses composed by equations 7 and 8 we obtain the equilibrium prices when information is shared:

$$p_s^I = \frac{2c_s - (1-f)(c_p\gamma + v(2-\gamma-\gamma^2))}{(1-f)(4-(1+f)\gamma^2)},$$

$$p_p^I = \frac{2c_p(1-f) + c_s(1+f)\gamma + v(1-f)(1-\gamma)(2+\gamma+f\gamma)}{(1-f)(4-(1+f)\gamma^2)}.$$

When the seller is not informed instead, it only knows the probability distribution of the demand realization, thus it takes into its best response the platform's expected best response which is defined as:

$$E\left(p_p(v, p_s)\right) = p_p(v^e, p_s) = \frac{1}{2}(v^e(1-\gamma) + c_p + (1+f)p_s\gamma)$$

where $v^e = \underline{v}(1-\delta) + \bar{v}\delta$. In this case, the seller's best response takes the following form:

$$p_s(v^e) = \frac{1}{2}\left(v^e(1-\gamma) + \frac{c_s}{1-f} + p_p(v^e, p_s)\gamma\right) \tag{9}$$

which, solving by p_s, gives the seller's equilibrium price when market information is not shared, formally:

$$p_s^N = \frac{2c_s + (1-f)(c_p\gamma + (2-\gamma-\gamma^2)(\underline{v}(1-\delta) + \bar{v}\delta))}{(1-f)(4-(1+f)\gamma^2)}$$

while the platform's equilibrium price without information sharing is:

$$p_p^N = \frac{1}{2}\left(c_p + v(1-\gamma) + \frac{\gamma(1+f)(2c_s + (1-f)(c_p\gamma + (2-\gamma-\gamma^2)(\underline{v}(1-\delta) + \bar{v}\delta)))}{(1-f)(4-(1+f)\gamma^2)}\right), \quad v \in \{\underline{v}, \bar{v}\}.$$

A.2 Firm profit

The expected profit of the firm under information sharing is:

$$\pi_I^e = \frac{(c_s((1+f)\gamma^2 - 2) + (1-f)(c_p\gamma + (2-\gamma-\gamma^2)(\underline{v}(1+\delta) + \bar{v}\delta))^2}{2(1-f)(1-\gamma)((1+f)\gamma^2 - 4)^2}. \tag{10}$$

The expected profit of the firm without information sharing is:

$$\pi_N^e = \pi_I^e - \frac{(\bar{v} - \underline{v})^2(1-f)(1-\gamma)(2+\gamma)^2(1-\delta)\delta}{2((1+f)\gamma^2 - 4)^2}$$

A.3 Platform profit

The expected profit of the platform when the seller is not informed is: $\Pi_N^e = \frac{1}{2(\gamma-1)((1+f)\gamma^2-4)^2}(\Lambda - (-1+\gamma)^2(2\bar{v}\underline{v}(-\gamma(4+\gamma)+f(-4+f\gamma^2))(-1+\delta)\delta - \bar{v}^2\delta(-4+f\gamma(-4+\gamma+\gamma^2)-4f\delta-\gamma(4+\gamma)\delta+f^2\gamma^2(\gamma+\delta))+$
$\underline{v}^2(-1+\delta)(-4+f^2\gamma^2(1+\gamma-\delta)+\gamma(4+\gamma)(-1+\delta)+f(-4-4\gamma+\gamma^2+\gamma^3+4\delta))))$
where
$\Lambda = \frac{c_s^2(4f-(1+f)^2\gamma^2)}{(f-1)^2} - c_p^2(4-(4+f)\gamma^2+(1+f)\gamma^4)+c_p\underline{v}(-1+\gamma)(8+\gamma(4+f^2\gamma^2(1+\gamma)-2\gamma(2+\gamma)+f(1+\gamma)((-2+\gamma)\gamma)-4))(-1+\delta)-c_p\bar{v}(\gamma-1)(8+\gamma(4+f^2\gamma^2(1+\gamma)-2\gamma(2+\gamma)+f(1+\gamma)(-4+(-2+\gamma)\gamma)))\delta+\frac{2c_s\gamma(c_p(-2+(1+f)\gamma^2)+(-1+\gamma)(2+\gamma+f\gamma)(\underline{v}(\delta-1)-\bar{v}\delta))}{f-1}$

while the expected platform profit under information sharing is

$$\Pi_I^e = \Pi_N^e + \frac{(\bar{v}-\underline{v})^2(2+\gamma)(1-\gamma)((1+f)^2\gamma^3-8f-4(2+f)\gamma+2(f^2-1)\gamma^2)(1-\delta)\delta}{8((1+f)\gamma^2-4)^2}.$$

A.4 Information sharing gains in price competition

We want to show the platform's gains of sharing information in price competition. Results are reported assuming a revenue sharing fee f equal to zero in order to isolate pricing strategies from any intermediation effect.

Platform's profit variation after information is shared when the realized demand is high:

$$\Delta\Pi(v=\bar{v}) = \frac{\bar{\Gamma}+(2c_s\gamma+2c_p(\gamma^2-2)+(\gamma^2+\gamma-2)(\underline{v}\gamma(\delta-1)+\bar{v}(\gamma-\gamma\delta-2))^2}{8(\gamma-1)(\gamma^2-4)^2} \tag{11}$$

where

$$\bar{\Gamma} = -4(c_s\gamma+c_p(\gamma^2)-2)-\bar{v}(\gamma^2+\gamma-2))^2.$$

Platform's profit variation after information is shared when the realized demand is low:

$$\Delta\Pi(v=\underline{v}) = \frac{\underline{\Gamma}+(2c_s\gamma+2c_p(\gamma^2-2)+(\gamma^2+\gamma-2)(-2\underline{v}-(\bar{v}-\underline{v})\gamma\delta))^2}{8(\gamma-1)(\gamma^2-4)^2} \tag{12}$$

where

$$\underline{\Gamma} = -4(c_s\gamma+c_p(\gamma^2)-2)-\underline{v}(\gamma^2+\gamma-2))^2.$$

By taking the weighted sum of equation 11 and equation 12, assuming marginal costs equal to zero for tractability we get:

$$\frac{(\bar{v}-\underline{v})^2(4-\gamma)(1-\gamma)\gamma(1-\delta)\delta}{8(\gamma-2)^2} \geq 0$$

which is the platform's net absolute gain from information sharing with its competitor, this gain is always non-negative

A.5 Consumer surplus

The expected consumer surplus with information sharing

$\mathrm{CS}_I^e = \frac{1}{4(-1+\gamma)(-4+(1+f)\gamma^2)^2}(c_p^2(-4+3\gamma^2) + \frac{c_s^2(-4-(-3+f)(1+f)\gamma^2)}{(-1+f)^2} - 2c_p\underline{v}(-1+\gamma)(-4+\gamma(-4-\gamma+2f(1+\gamma)))(-1+\delta) + 2c_p\bar{v}(-1+\gamma)(-4+\gamma(-4-\gamma+2f(1+\gamma)))\delta - (-1+\gamma)(8+2\gamma(4+\gamma)+f\gamma(1+\gamma)(-4+(-2+f)\gamma))(\underline{v}^2(-1+\delta)-\bar{v}^2\delta)+\Omega).$

where

$$\Omega = \frac{2c_s(2c_pf\gamma - c_p(1+f)\gamma^3 + (-1+\gamma)(-4+\gamma(-4- \gamma+f(-2+\gamma(f+\gamma+f\gamma))))(\underline{v}(-1+\delta)-\bar{v}\delta))}{f-1}.$$

The expected consumer surplus without information sharing is:

$$CS_N^e = CS_I^e - \frac{(\bar{v}-\underline{v})^2(1-\gamma)(2+\gamma)(2+\gamma+f\gamma)(-12+2(f-2)\gamma+3(1+f)\gamma^2)(1-\delta)\delta}{16((1+f)\gamma^2-4)^2}.$$

A.6 Firm profit under agency

The expected profit of the firm under agency with information sharing is

$$\pi_{I_A}^e = \frac{(-1+\gamma)((c_s+(-1+f)\underline{v})^2(1-\delta)+(c_s+(-1+f)\bar{v})^2\delta)}{2(-1+f)(-2+\gamma)^2}.$$

While the expected profit of the seller under agency when it is not informed is:

$$\pi_{N_A}^e = -\frac{f(c_s-(-1+f)(\underline{v}(-1+\delta)-\bar{v}\delta))(c_s-(-1+f)(-1+\gamma)(\underline{v}(-1+\delta)-\bar{v}\delta))}{2(-1+f)(-2+\gamma)^2}.$$

A.7 Platform profit under agency

The expected profit of the platform when the seller is not informed is:

$$\Pi_{N_A}^e = \frac{f((1-f)(\underline{v}(1-\delta)+\bar{v}\delta)-c_s)(c_s-(-1+f)(-1+\gamma)(\underline{v}(-1+\delta)-\bar{v}\delta))}{(-1+f)^2(-2+\gamma)^2}$$

while the expected platform profit under information sharing is

$$\Pi^e_{I_A} = \frac{f(c_s(f-1)\gamma(\underline{v}(-1+\delta)-\bar{v}\delta-c_s^2)+(-1+f)^2(-1+\gamma)(\underline{v}^2(-1+\delta)-\bar{v}^2\delta))}{(-1+f)^2(-2+\gamma)^2}.$$

A.8 Consumer surplus under agency

The expected consumer surplus without information sharing

$$CS^e_{N_A} = \frac{(1-\delta)\Omega^2+\delta(c_s-(f-1)(\underline{v}(1-\gamma)(1-\delta)+\bar{v}(\gamma+\delta-\gamma\delta-2)))^2}{2(f-1)^2(\gamma-2)^2} \tag{13}$$

where

$$\Omega = c_s + (f-1)(\underline{v}+(\bar{v}-\underline{v})(\gamma-1)\delta).$$

The expected consumer surplus with information sharing is:

$$CS^e_{I_A} = \frac{(1-\delta)(c_s+(f-1)\underline{v})^2+\delta(c_s+(f-1)\bar{v})^2}{2(f-1)^2(\gamma-2)^2}. \tag{14}$$

A.9 Platform entry decision: alternative timing

We are interested in investigating an alternative timing in which he platform decides the business mode first and then the information policy. As before, entering the product space consists in the platform acquiring one of the two retailers by paying a price equal to the profit that the firm makes under agency. Since the platform decides the business mode first and then the information policy, the cost of the acquisition is the same in every sub-game, namely the profit of the seller without information provision (π^e_N). From Proposition 1 and Lemma 6, we know that in both business modes the platform has incentives to share market information. Therefore, the equilibrium profit of the platform is the highest profit between agency with information sharing and dual mode with information sharing, net of the acquisition of the uninformed seller; formally:

$$max\{\Pi^e_I - \pi^e_N, \Pi^e_{I_A}\}.$$

In the unique equilibrium of the game, the platform always enters the market and then provides market information unless it is less cost efficient than the seller, in this case it prefers to stay out of the market but still providing market information. The most profitable strategy for the platform is to acquire one of the sellers and then provide market information to the other one unless it faces a selling cost that is too high with respect to the seller's one. In this latter case it is better for the platform to not acquire any of the sellers and to keep operating under agency. Nevertheless, it still provides market information.