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PLATFORM DESIGN AND RENT EXTRACTION*

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We study the design of online platforms that aggregate information and facilitate transactions. Leading players in the industry (e.g., the Booking Group) hold two types of platforms in their portfolio: revealing platforms that disclose the identity of transaction partners (like Booking.com) and anonymous platforms that do not (like Hotwire.com). Anonymous platforms offer discounts but lead to inefficient matching between consumers and firms. We develop a model in which horizontally differentiated firms sell to heterogeneous consumers both directly and via a platform that enlarges the pool of consumers they can attract. The platform charges firms for transactions it intermediates and can choose to offer an anonymous sales channel in addition to a revealing one. We show that offering both sales channels is profitable not only because it allows the platform to implement price discrimination,

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as suggested by the literature on opaque selling, but also because it improves rent extraction. The anonymous channel breaks the link between the price on the revealing channel and the firms' outside option; moreover, it can reduce double marginalisation. The welfare impact of the anonymous channel is ambiguous: while it sometimes leads to market expansion, it also causes inefficiently high transport costs.

I. INTRODUCTION

Online platforms that aggregate information and facilitate transactions play an increasingly important role in many markets. A leading example is the tourism industry, where online travel agencies like Booking.com allow consumers to search and directly make reservations for hotel rooms and other properties. The success of these platforms is largely due to the fact that they make it much easier for consumers to find products that match their preferences. By aggregating information on the characteristics and prices of the products available in the market, the platforms reduce search costs. In addition, they provide consumers with a seamless online experience that allows them to search, compare, and book accommodation options in real time, and enhance trust by guaranteeing secure payments and disclosing customer reviews.

Generally, two different platform designs can be observed: *anonymous* and *revealing*. Anonymous platforms hide the identity of the transaction partners until after the transaction has been completed, while revealing platforms disclose the identity of at least one side of the transaction (usually the seller's) from the outset. Examples of revealing platforms include Booking.com or Expedia.com, while anonymous platforms include Hotwire.com and Priceline.com's 'Express Deals' feature.[1] Anonymous platforms typically promise travellers steep discounts.[2]

This paper is motivated by two key observations. First, the design of the anonymous platform results in a loss of information. The platform cannot hide a seller's identity without also hiding certain relevant product

[1] While data on the market shares of revealing and anonymous platforms is hard to obtain, internet traffic data suggests that both are important. For example, the Expedia Group reports that, in January 2020, their revealing platform Expedia.com received 48 million monthly unique visitors, while their anonymous platform Hotwire.com received 8.5 million monthly unique visitors; see *https://web.archive.org/web/20220120115515/https://advertising.expedia.com/getting-started/brands/expedia/* and *https://web.archive.org/web/20220523032103/https://advertising.expedia.com/getting-started/brands/hotwire/* (both last accessed on 24 July 2024).

[2] Both Priceline.com's 'Express Deals' and Hotwire.com advertise savings of up to 60% on hotels; see *https://www.priceline.com/hotels?modal=express-deals* and *https://www.hotwire.com/hotels/* (both last accessed on 24 July 2024). Courty and Liu [2013] (using data from Hotwire.com) and Tappata and Cossa [2014] (using user-reported information) estimate that the same hotel room sells at an average discount of about 40% on anonymous channels compared to revealing channels.

characteristics, such as the seller's precise location. While this prevents buyers and sellers from transacting outside the platform—a key consideration, given that the platforms' business model is to charge sellers for the transactions they intermediate—it also leads to inefficiencies in the allocation of buyers to sellers, as buyers are unable to choose the seller whose location best matches their preferences. This undermines what is arguably the main reason for the existence of these online platforms, namely, to ensure better matches. Yet, anonymous platforms have been a feature of the tourism-industry landscape for more than two decades, suggesting they are part of a successful business model.

The second striking observation is that the market leaders tend to have both revealing and anonymous platforms in their portfolio: Booking Holdings owns Booking.com and Priceline.com, while the Expedia Group owns Expedia.com and Hotwire.com. This may seem surprising, as one would expect the platforms to avoid creating competition for their flagship services. The introduction of an anonymous platform offering discounts would seemingly put pressure on hotel prices, thus shrinking the size of the pie that can be shared among hotels and platforms.

Our paper investigates why it might be profitable for an online platform to introduce an anonymous sales channel in addition to a revealing one, and how this affects platform users—consumers and firms—as well as welfare. To this end, we develop a model in which two firms offer their products for sale both directly and via an online platform. The firms' products differ in their *location*, at either end of a Hotelling line. Consumers are distributed along the Hotelling line and incur transport costs to travel to a firm. Some consumers can only find the firms if their products are available through the platform, while others can also find them if they only sell directly. This is a simple way of capturing the notion that the platform creates value by enlarging the pool of consumers the firms can attract, perhaps because it reduces search costs or fosters trust.

The platform can provide its intermediation services either via a single sales channel with a revealing design or via two channels, one with a revealing and the other with an anonymous design. On the revealing channel, the platform discloses both the prices and locations of the firms. On the anonymous channel, the platform discloses only the prices of the firms, listed in random order, so that consumers do not observe their locations. When the platform makes both channels available, firms can charge different prices on each channel.

In exchange for its services, the platform offers firms a two-part tariff, consisting of a fixed fee and a transaction fee.[3] We allow the transaction fee to differ across sales channels, and we assume that the platform imposes a

[3] In practice, two-part tariffs may sometimes be hard to implement. In Section V and Appendix B, we therefore consider an extension with linear pricing (i.e., without fixed fees).

price parity clause—sometimes called a most-favoured-nation (MFN) or most-favoured-customer (MFC) clause—that prevents firms from inducing consumers to 'showroom' on the platform only to buy their product more cheaply via the direct channel.[4] The platform gives firms access to a larger market, but due to the firms' outside option of selling directly to consumers, it cannot extract all their surplus.

The platform can indirectly control equilibrium prices via the transaction fee and extract profits via the fixed fee. It therefore maximises industry profits net of the firms' outside option. The outside option, which equals the deviation profit a firm could obtain by selling only directly, is increasing in the transaction fee, which acts as a marginal cost for rivals who have accepted the platform's contract. We show that, if the share of consumers with access to direct sales is large, it is optimal for the platform to decrease the transaction fee below the level that would maximise industry profits in order to reduce deviation profits.

When the platform uses only a revealing sales channel, there is sometimes no conflict between maximising industry profit and minimising deviation profit: as long as products are sufficiently differentiated for firms to be local monopolists, equilibrium prices are industry profit-maximising even when the fee is zero. It is only for less differentiated products that the platform wants to soften competition by introducing transaction fees.

When there is both a revealing and an anonymous sales channel, and provided the price is lower on the anonymous channel, consumers located towards the boundaries (who have strong preferences for a specific firm) buy via the revealing channel, while those located towards the middle buy via the anonymous channel. On the anonymous channel, firms are perceived as homogeneous, resulting in Bertrand-like competition that drives the price down to marginal cost. While this puts pressure on prices, the platform can control firms' marginal cost and, hence, prices via the transaction fee. The platform will always find it optimal to charge strictly positive transaction fees on both channels, as otherwise equilibrium prices would be below those that maximise industry profits. On the anonymous channel, this is because competition is too intense; on the revealing channel, this is because firms do not take into account the platform's revenue from anonymous-channel sales when setting prices for the revealing channel.

[4] Price parity clauses have recently come under scrutiny from antitrust authorities in Europe and Asia. However, they are primarily concerned about so-called 'wide' price parity clauses, which prohibit firms from offering a lower price on a competing platform. So-called 'narrow' price parity clauses, which only prohibit firms from setting a lower price when selling directly to consumers, have been justified on the grounds that they protect the platform's investment and are usually deemed lawful (Argenton and Geradin [2021]). This difference in treatment is reflected in the recent revisions of the European Commission's Guidelines on Vertical Restraints (EC, European Commission [2022]) and the Vertical Block Exemption Regulation. For more on price parity clauses, see Johnson [2017]; Wang and Wright [2020]; Calzada *et al.* [2022]; Ronayne and Taylor [2022] and the literature review by Argenton and Geradin [2021].

Our analysis shows that it is always profitable for the platform to introduce the anonymous channel. There are three reasons for this. First, by introducing the anonymous sales channel the platform enables the firms to engage in *price discrimination*. The anonymous channel attracts a specific subset of consumers —namely, those who do not care much about location. Its presence allows the firms to raise prices on consumers who care strongly about location, and thus buy via the revealing channel, without losing consumers who care little. This increases industry profits.

Second, the presence of the anonymous channel leads to a *decoupling* of the firms' deviation profits from the equilibrium price on the revealing channel. In its absence, raising the price on the revealing channel also raises deviation profits, and thus the surplus the platform needs to leave to firms. But when two sales channels are active, deviation profits depend only on the lower of the two prices, which in equilibrium turns out to be the price on the anonymous channel. Holding constant the anonymous-channel transaction fee, the platform can thus increase the revealing-channel fee without weakening its bargaining position vis-à-vis firms.

Third, we show in an extension that, if the platform cannot use fixed fees, the anonymous channel creates an additional mechanism for rent extraction. Without fixed fees, the platform has only one instrument—transaction fees—to control firms' price-setting behaviour and extract their surplus. The platform then suffers from a double-marginalisation problem, as the firms charge mark-ups that push the price above the level that would maximise joint profits. By making products appear homogeneous to consumers, the anonymous channel creates more intense *competition*. This eliminates double marginalisation and helps the platform extract rents. We further show that the platform exploits this by driving up prices on the revealing channel and diverting consumers to the anonymous one.

Turning to the effects of the anonymous channel on platform users and welfare, our results are mixed. We find that consumers are always negatively affected, that firms are indifferent and that the overall welfare effect is ambiguous. The unambiguously negative effect on consumers is due to the way the platform sets transaction fees, namely, so as to extract all surplus from consumers buying via the anonymous channel and raise prices for those buying via the revealing channel. Thus, even when the anonymous channel draws additional consumers into the market, they do not receive any surplus. For firms, the introduction of the anonymous channel is neutral because the platform can extract the extra profits it generates without having to leave more surplus to firms, thanks to the decoupling of deviation profits from revealing-channel prices discussed above.[5]

[5] Note that in the extension without fixed fees, firms are harmed by the introduction of the anonymous channel.

The intuition for the ambiguous effect on welfare (total surplus) is that the anonymous channel creates a trade-off between information loss and market expansion. On the one hand, some consumers switch from the revealing channel to the anonymous channel, and these consumers end up travelling further than they should because they are assigned to a random firm rather than to the closest one. On the other hand, the anonymous channel draws some additional consumers into the market who were not buying before.

The market-expanding effect is only present when the market is not fully covered prior to the introduction of the anonymous channel. Otherwise, only the first, information-destroying effect is present. Accordingly, the net welfare effect is positive when transport costs are high and negative when transport costs are low. Although the social cost of information loss increases with transport costs, high transport costs also confer market power on firms, which leads to some consumers being priced out of the market. This is when the market expansion generated by the anonymous channel is most beneficial.

Our analysis has implications for the regulation of digital markets. The results suggest that anonymous platforms, though seemingly benign, should be closely scrutinised by regulators. Anonymous platforms can generate welfare gains in markets where firms hold market power (either because of product differentiation—the focus of our formal analysis—or for other reasons). However, in reasonably competitive markets, the efficiencies related to market expansion are unlikely to offset the inefficiencies in the allocation of consumers to firms that anonymous platforms cause. These policy implications seem particularly timely in light of recent debate over whether and how to reign in large online platforms (see, e.g., OECD [2021]). This debate has spurred legislative initiatives to regulate platforms on both sides of the Atlantic, including the digital markets act (DMA) and the digital services act (DSA) in the European Union, which impose new obligations on so-called 'gatekeepers' (in the case of the DMA) and 'very large online platforms' (in the case of the DSA).[6]

The remainder of the paper is organised as follows. Section I(i) briefly discusses how our work relates to the existing literature. Section II considers a simple example highlighting some of the key forces at work in our model. Section III then presents the fully fledged model. Section IV studies the

[6] In May 2024, Booking was designated as a gatekeeper under the DMA by the European Commission, joining six other tech companies that had been designated in September 2023; see *https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2561* (last accessed on 24 July 2024). The gatekeeper designation subjects firms to additional obligations aimed at giving users "fair" access to their services. In April 2023, the Commission had already designated Booking.com as one of 17 very large online platforms that have to comply with a bundle of new obligations introduced by the DSA; see *https://ec.europa.eu/commission/presscorner/detail/en/IP_23_2413* (last accessed on 24 July 2024).

equilibrium for the case in which the platform operates only a single, revealing sales channel, while Section IV(ii) considers the case in which both a revealing and an anonymous channel are active. Section IV(iii) compares the results from the previous two sections to evaluate how the introduction of an anonymous channel impacts profits, consumer surplus, and welfare. Section V discusses how our results are likely to change if the platform has to rely solely on transaction fees and if there are competing platforms. Section VI concludes. All proofs are relegated to Appendix A.

I(i). *Related Literature*

At a general level, we build on a large body of work on online intermediaries (i.e. platforms). Spulber [2019] and Jullien and Sand-Zantman [2021] provide reviews of the literature.[7] Our model is static and studies the case of a single platform. Readers interested in dynamic models of platforms should consult Cabral [2019] and Kanoria and Saban [2021]. Those interested in multi-homing and competition among platforms should consult Casadesus-Masanell and Campbell [2019], Halaburda and Yehezkel [2019], and Karle *et al.* [2020] as well as the literature cited therein.

Information plays a crucial role in our model. By definition, anonymous platforms differ from direct sales or revealing platforms in the information provided to potential buyers. In that sense, our approach is related to the literature on obfuscation, where the seller optimally decides the amount of information to reveal.[8] Contrary to the obfuscation literature, we take the amount of hidden information as exogenous and interpret it as a design choice of the platform. Also, we let consumers choose the sales channel and, hence, consumers select their preferred pair of price and product information.

Our work relates to the literature on firms selling 'opaque products', that is, products for which some characteristics are voluntarily withheld by the seller. Anderson and Celik [2020] and Balestrieri *et al.* [2021] focus on the case of a multi-product monopolist selling a set of base goods as well as an opaque good, which is randomly drawn among the base goods, and show that opacity can raise profits by enabling the monopolist to price discriminate. Loertscher and Muir [2024] consider a monopolist selling goods located at each end of the Hotelling line. They derive the optimal selling mechanism when buyers are privately informed about their locations and identify conditions under which running separate lotteries for each good benefits the seller. Although their

[7] Spulber [2019] offers insights on how the economics of platforms differs from the standard partial and general equilibrium literature. Jullien and Sand-Zantman [2021] focus instead on competition and competition policy.

[8] See, among others, Ganuza [2004]; Ellison and Ellison [2009]; Celik [2014]; Janssen and Teteryatnikova [2016]; Petrikaitė [2018]; Jullien and Pavan [2019]; Romanyuk and Smolin [2019]; Armstrong and Zhou [2022]; Heresi [2023].

setup is quite different from ours, they obtain a similar inefficiency result: because the optimal mechanism always involves some buyer types entering a lottery, these types may end up not being assigned the product closest to their location.

Fay [2008] and Shapiro and Shi [2008] allow for competition across sellers and are, perhaps, the contributions that are closest to ours. Like us, they model firms as selling horizontally differentiated products to heterogeneous consumers (defined spatially, through a linear (Fay [2008]) or circular (Shapiro and Shi [2008]) city) and consider an intermediary offering an opaque product. There are, however, a number of crucial differences between our model and theirs.

First, both Fay [2008] and Shapiro and Shi [2008] guarantee by design that a subset of consumers always buys from each firm and competition takes place only for the residual demand.[9] In our model, the fact that some consumers always buy through the revealing channel arises endogenously as an equilibrium outcome, rather than by assumption. Second, although these papers are also motivated by the online travel industry, neither of them models the intermediary as a marketplace charging firms for transactions, which is the dominant business model in that industry. In Fay [2008], the intermediary buys capacity from firms and resells it; in Shapiro and Shi [2008], the intermediary is not a strategic actor and does not charge fees. Moreover, neither of them considers the case where the platform uses two different sales channels (revealing and anonymous). Therefore, they cannot study how the platform strategically sets fees to influence firms' pricing, how it coordinates fees across the two channels, and how this depends on the firms' outside option of selling directly to consumers, which is the focus of our paper. Finally, because both papers assume that the market is covered, they cannot study the potential market-expanding effect of opaque selling. As we show, market expansion is important to understand the welfare impact of this practice.

Despite having similar appearance, our model is intrinsically different from the literature in which platforms are used as a search device (Baye and Morgan [2001]; Dinerstein *et al.* [2018]; Ronayne [2021]; Ronayne and Taylor [2022]). Indeed, prices in our model are ex-ante observable and consumers' misinformation is about the product characteristics.

The literature supports two features in our model. First, platforms can convey relevant information to potential consumers, even in the presence of fake reviews. The empirical literature has tested this claim in various ways and, overall, there is support for the notion that platforms are able to transmit

[9] Fay [2008] assumes that a fixed share of the population is loyal to a brand, while Shapiro and Shi [2008] assume that a share of the population has prohibitive transport costs and always buys from the closest firm.

valuable information even if a share of the reviews is fake.[10] Second, products are primarily differentiated in a horizontal dimension within a platform, with the vertical dimension being secondary (Cabral and Hortaçsu [2010]; Hossain *et al.* [2011]; Klein *et al.* [2016]; Vial and Zurita [2017]). The intuition is that poorly ranked products either disappear or converge to their competitors' quality.

II. AN EXAMPLE

Before describing the fully fledged model, in this section we provide a simple example that illustrates some of the main insights of our analysis. For ease of exposition, we omit some of the details of the derivations, which can be found in Section IV and Appendix B.

Consider a Hotelling duopoly with linear transportation costs. Firms are located at the endpoints of the Hotelling line, and consumers obtain utility $v - td - p$ when buying from a firm located at distance d from their own location. For the example, assume $0 < t/2 \le v \le 2t$.

Consumers can access firms only via a platform. The platform provides access through two sales channels: a *revealing* and an *anonymous* channel. On the revealing channel, consumers observe both prices and locations, whereas on the anonymous channel, they observe only prices but not locations.

The platform charges firms per-transaction fees ϕ^r and ϕ^a for sales occurring via the revealing and anonymous channel, respectively. After observing the fees, firms simultaneously choose prices for each channel. Consumers decide whether and through which channel to buy.

Suppose first that the platform only uses a revealing channel, on which it charges a fee ϕ. Then the symmetric equilibrium price firms set for ϕ sufficiently large is $p = (v + \phi)/2$. To maximise its profits, the platform sets $\phi = v/2$, resulting in a price of $p = 3v/4$. Notice that the market is not fully covered unless $v = 2t$; for $v < 2t$ the consumer at $1/2$ obtains negative utility from buying and therefore abstains.

Now suppose the platform introduces an anonymous channel in addition to the revealing one. All consumers buying via the anonymous channel at a price of p obtain expected utility $v - t/2 - p$, regardless of their location, because they are equally likely to end up at either firm. Products thus appear ex ante homogeneous to consumers on the anonymous channel. This leads to Bertrand-like competition, driving anonymous-channel prices down to marginal cost: in equilibrium, $p^a = \phi^a$.

[10] Fradkin *et al.* [2021] establish this using data from the anonymous platform Airbnb, while the remaining literature (including Chevalier and Mayzlin [2006]; Dellarocas [2006]; Anderson and Magruder [2012]; Ghose *et al.* [2012]; Mayzlin *et al.* [2013]; Luca and Zervas [2016]) uses data from revealing platforms.

By setting $\phi^a = v - t/2$, the platform extracts the entire surplus from consumers buying via the anonymous channel, and the market is always covered, regardless of the price on the revealing channel. Notice that this also implies that, for consumers contemplating a purchase via the revealing channel, the value of the outside option is the same as in the absence of the anonymous channel (namely, zero). Hence, the revealing-channel pricing game still has the same equilibrium, with $p^r = (v + \phi^r)/2$.

The platform could simply continue to set $\phi^r = v/2$ on the revealing channel. If the market is not covered with only the revealing channel active, the introduction of the anonymous channel then strictly raises the platform's profits, as previously inactive consumers now buy via the anonymous channel while previously active consumers continue to buy via the revealing channel.

Even if the market is covered with only the revealing channel active (i.e. if $v = 2t$), introducing the anonymous channel increases the platform's profit because setting $\phi^r = v/2$ is not optimal. Raising ϕ^r (and thus equilibrium prices) no longer leads consumers to drop out, so the platform's tradeoff changes. The marginal benefit of raising the fee, in terms of higher revenues from inframarginal consumers, is unchanged, but the marginal cost, in terms of reduced revenue from the marginal consumer, is lower. By increasing ϕ^r slightly above $v/2$ the platform earns strictly higher profit.

The welfare tradeoff associated with the anonymous channel is as follows. If prior to its introduction the market is not covered, then there is a positive welfare effect due to market expansion. Consumers who were previously getting priced out of the market now buy via the anonymous channel (although the surplus is captured entirely by the platform). There is also a negative effect due to inefficient matching of consumers to firms. On the anonymous channel, consumers are matched to a random firm, rather than to the closest one. As we show below, the market-expansion effect dominates the inefficient-matching effect when t is large relative to v, whereas the opposite holds when t is small.

In the following section, we formally develop a setting that is more general than the one in this example, as it allows for two-part tariffs, providing the platform with an additional pricing instrument, and introduces an outside option for firms, which can bypass the platform and sell directly to consumers. As the analysis will show, the main insights conveyed by the example in this section carry over to the more general setting. In addition, the more general setting allows us to flesh out richer and more nuanced results that the simplicity of the example fails to capture.[11]

[11] Appendix B contains the analysis for the case without fixed fees and outside option considered in the example, and provides results also for the case $v > 2t$.

III. MODEL

Two firms selling a single good are located at opposite ends of the Hotelling line and indexed by their location, $j = 0, 1$. A mass 1 of consumers is uniformly distributed along the line. A consumer at $x \in [0, 1]$ who purchases from firm 0 (1) at a price of p_0 (p_1) obtains $u_0 = v - tx - p_0$ ($u_1 = v - t(1 - x) - p_1$), where $t > 0$ is a parameter measuring transport costs.

An online platform aggregates information on firms and facilitates transactions. The platform is a third-party intermediary that can provide access to the goods offered by the firms through two sales channels: a *revealing* channel and an *anonymous* channel. The firms can also sell *directly* to consumers (through a brick-and-mortar store or through a proprietary website of the firm), rather than through the platform.

Sales channels differ in the information available to consumers at the time of purchase. Consumers who buy either via the platform's revealing channel or directly from the firms observe both prices and locations. Consumers who buy via the platform's anonymous channel observe prices but not locations, as explained in more detail below. To make the analysis interesting, we impose the following assumption.

Assumption 1. The anonymous sales channel is viable: $v \geq t/2$.

When buying via the anonymous channel at a price of p^a, consumers who believe they are equally likely to obtain either firm's product have expected utility $v - t/2 - p^a$ regardless of their location x. Thus, for $v < t/2$, no consumer gets positive expected utility from a purchase on the anonymous channel, even at a price of zero.

There are two types of consumers: type $\mathcal{A}$ and type $\mathcal{B}$. Type-$\mathcal{A}$ consumers make up a fraction α of the total population and can reach all firms, regardless of how they sell their products (directly or through a platform). Type-$\mathcal{B}$ consumers make up the remaining fraction $1 - \alpha$ of the population and can reach firms that are listed on the platform but not those that only sell directly to consumers.[12] Table I summarises how consumers' information differs across sales channels and consumer types $\mathcal{A}$ and $\mathcal{B}$.

On the anonymous channel, the platform discloses the prices of the available products but not the identities of the firms that sell them. The seller's identity is hidden until the transaction is concluded. Hence, at the time of purchase, consumers are unable to compute the transport cost they will incur and need to form beliefs about seller locations. Formally, the platform posts a list L of product offers available via the channel, with $L \in \{(p_0, p_1), (p_1, p_0)\}$,

[12] This assumption is similar in spirit to Baye and Morgan [2001], who assume that, in the absence of an information intermediary, each firm attracts only a subset of consumers, namely, those located in the same geographic area.

TABLE I
SALES CHANNELS AND CONSUMER INFORMATION

	Direct	Revealing	Anonymous
Type $\mathcal{A}$	Prices and locations	Prices and locations	Prices
Type $\mathcal{B}$	$\varnothing$	Prices and locations	Prices

where p_j is the price charged by firm j. On the revealing channel, the platform always posts $L = (p_0, p_1)$; hence, consumers know that the first option in the list corresponds to firm 0's offer and the second to firm 1's offer. An anonymous platform posts

$$L = \begin{cases} (p_0, p_1) & \text{with probability } 1/2, \\ (p_1, p_0) & \text{with probability } 1/2, \end{cases}$$

hence, consumers do not know which option in the list corresponds to which firm.

The platform makes a take-it-or-leave-it offer to firms, comprising a fixed fee F as well as per-unit fees ϕ^a and ϕ^r for transactions occurring via the anonymous and revealing channel, respectively. Section V and Appendix B consider the case where the platform cannot use fixed fees and has to rely exclusively on transaction fees (linear pricing).

The contract does not allow the firms to choose which channel to be listed on. We assume that the contract includes a 'price parity clause' (also known as MFN clause), which prevents firms who accept the platform's contract from offering their product at a lower price through the direct channel than through the platform's revealing channel.

The timing is as follows:

1. The platform offers a contract (F, ϕ^a, ϕ^r) to be listed.
2. Firms accept or reject. If they accept, they pay the fixed fee F to the platform.
3. Without observing whether the rival has accepted, firms set prices for direct sales (p_j^d), sales via the platform's revealing channel (p_j^r), and sales via the platform's anonymous channel (p_j^a). The presence of a price parity clause implies that firms that accepted the contract cannot undercut the price on the platform ($p_j^d \geq p_j^r$).
4. The platform posts a list of available product offers L^s on each of its sales channels, $s = r, a$.
5. Consumers decide whether to buy directly from firm $j \in \{0, 1\}$, or via the platform's revealing or anonymous channel, or not to buy at all. If they buy through channel s, they choose between the first option and the second option in list L^s. Type-$\mathcal{B}$ consumers only observe firms listed on the platform.

Our solution concept is Perfect Bayesian equilibrium (PBE). On the revealing channel, the game is one of complete information: seller locations are common knowledge. In that case, PBE collapses to subgame-perfect Nash equilibrium. On the anonymous channel, the game is one of incomplete information: sellers know their locations while consumers do not. In the analysis that follows, we restrict attention to symmetric equilibria, so prices do not convey information about sellers' locations (i.e., on the equilibrium path consumers believe that a firm selling via the anonymous channel is equally likely to be located at either end of the Hotelling line). However, if out-of-equilibrium beliefs about locations are allowed to depend on prices, many different prices can be supported as an equilibrium. To deal with this multiplicity, we impose the refinement that beliefs are *passive*: when observing an unexpected price, consumers do not revise their beliefs about the location of the deviating firm.[13]

IV. ANALYSIS

We start by considering the case in which the platform only has a revealing channel and then turn to the case where it has both a revealing and an anonymous channel. Throughout the analysis, we focus on the equilibrium in which both firms decide to use the platform. That is, we assume that the platform sets (F, ϕ^a, ϕ^r) in order to ensure that both firms accept the contract. Each firm's outside option is to deviate and use only the direct sales channel.

We also assume that ceteris paribus consumers prefer to buy via the platform. Combined with the price parity clause, this implies that firms cannot divert buyers from the revealing platform to their direct sales channel. The direct channel only determines the firms' outside option and, hence, the rent that the platform must leave to them.

IV(i). *Revealing Channel Only*

In this section, we consider the case in which the platform only makes a revealing sales channel available. Notice that it can never be optimal for a firm to set $p_j > v$, as otherwise nobody would buy. Similarly, nobody would buy from a firm if its price exceeded the competitor's price by more than the transport cost ($p_j > p_{-j} + t$). Hence, it cannot be optimal for firm j to set $p_j \leq v$ and $p_j > p_{-j} + t$, which would lead to a case where firm j serves nobody while the other serves the whole market and leaves some surplus to all buyers. Should this be the case, firm j would have an incentive to decrease the price, while the competitor would have an incentive to increase it.

[13] Passive beliefs are common in the industrial-organisation literature, particularly (though not only) in the context of vertical contracts (see Rey and Tirole [2007]).

In what follows we thus assume $p_j \leq v$ for all j and $|p_1 - p_0| \leq t$. Under those conditions, the share of consumers who buy from firm 0, for a given p_1, is:

$$q_0(p_0, p_1) = \begin{cases} \frac{v-p_0}{t} & \text{if } p_0 > 2v - t - p_1, \\ \frac{1}{2}\left(1 + \frac{p_1-p_0}{t}\right) & \text{if } p_0 \leq 2v - t - p_1. \end{cases} \quad (1)$$

At the cutoff price between the demand regimes, where $p_0 = 2v - t - p_1$, the consumer who is exactly indifferent between buying from firms 0 and 1, located at $\tilde{x} = 1/2 + (p_1 - p_0)/2t$, receives a utility of zero. For p_0 below the cutoff, the market is covered; for p_0 above the cutoff, the market is not covered.[14] Firm 0's profit is $\pi_0 = q_0(p_0 - \phi) - F$. (Note: Here and in what follows, we drop the dependence of functions on their arguments to improve readability whenever this does not create confusion.)

Lemma 1. If only the revealing channel is available, the symmetric equilibrium price is given by

$$p(\phi) = \begin{cases} t + \phi & \text{for } \phi \leq v - 3t/2, \\ v - \frac{t}{2} & \text{for } v - 3t/2 < \phi \leq v - t, \\ \frac{v+\phi}{2} & \text{for } \phi > v - t. \end{cases} \quad (2)$$

Proof. See Appendix A. ■

The equilibrium reflects the fact that firms face a kinked demand function, resulting in a discontinuity in marginal revenue at $p_j = 2v - t - p_{-j}$. For low values of ϕ, the firms compete à la Hotelling; for high values, they are local monopolists. In an intermediate range of ϕ, the equilibrium is such that firms price exactly at the kink. Notice that the market is covered for $p \leq v - t/2$ and thus for $\phi \leq v - t$. For $\phi > v - t$, total demand is $q_0 + q_1 = 2(v - p)/t = (v - \phi)/t$.

Letting $Q(p)$ denote each firm's demand when the symmetric equilibrium price is p, the platform's problem is $\max_{F,\phi} 2F + 2\phi Q(p(\phi))$ subject to $F \leq (p(\phi) - \phi)Q(p(\phi)) - \pi_D(\phi)$, where π_D is the firm's deviation profit (outside option), that is, the profit from rejecting the platform's contract and selling directly to consumers while the rival sells through the platform. The constraint must be binding at the optimum, so the platform's problem becomes

$$\max_{\phi} \Pi(\phi) - 2\pi_D(\phi), \quad (3)$$

[14] Note that we do not have to condition on whether or not $p_1 \geq v - t$. Even though, for $p_1 < v - t$, all consumers receive strictly positive utility when buying from firm 1, so that the market is necessarily covered, our earlier argument that we can restrict attention to prices $p_j \leq v$ implies that, when $p_1 < v - t$ and hence $2v - t - p_1 > v$, we cannot have $p_0 > 2v - t - p_1$.

where $\Pi \equiv 2pQ(p)$ is industry profit. The platform thus chooses ϕ to maximise industry profits net of the deviation profit π_D it needs to leave to each firm.

In a symmetric equilibrium where all firms charge p, firms are local monopolists for $p > v - t/2$, while the market is covered for $p \leq v - t/2$, in which case each firm serves $1/2$ of consumers. We have

$$Q(p) = \begin{cases} \frac{v-p}{t} & \text{for } p > v - t/2, \\ \frac{1}{2} & \text{for } p \leq v - t/2. \end{cases} \tag{4}$$

A deviating firm can only reach type-$\mathcal{A}$ consumers. It will set its price to maximise profits given the price charged by the rival, which is determined by ϕ as specified in Lemma 1. The deviation profit is

$$\pi_D = \max_{p_0} \alpha p_0 q_0(p_0, p(\phi)). \tag{5}$$

As we show in the proof of Proposition 1, the deviation profit increases with ϕ. The transaction fee ϕ acts as a per-unit cost for a firm that accepts the platform's contract. Intuitively, the higher is ϕ, the less competitive is the firm that accepts the contract compared to the one that deviates and, thus, the higher is the deviator's profit.

The platform's optimal fee. By setting the appropriate ϕ, the platform could always ensure that the market price maximises industry profits. However, doing so is not always in the platform's interest. Proposition 1 derives the (platform's) profit maximising fee ϕ^* and indicates the platform's and firms' profits.

Proposition 1. If the platform only uses a revealing sales channel, the fee that maximises its profit is

$$\phi^* = \begin{cases} 0 & \text{for } v \leq 3t/2, \\ v - \frac{3t}{2} & \text{for } v > 3t/2 \text{ and } \alpha \leq \alpha^*, \\ \frac{2t(1-\alpha)}{\alpha} & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*, \end{cases} \tag{6}$$

where $\alpha^* \equiv \frac{4t}{t+2v}$.

Furthermore, given $\phi = \phi^*$, the platform's profit is

$$\pi^P = \begin{cases} \frac{(1-\alpha)v^2}{2t} & \text{for } v \leq t, \\ (1-\alpha)\left(v - \frac{t}{2}\right) & \text{for } t < v \leq 3t/2, \\ v - \frac{t}{2} - \frac{\alpha}{4t}\left(v + \frac{t}{2}\right)^2 & \text{for } v > 3t/2 \text{ and } \alpha \leq \alpha^*, \\ t\left(\frac{1-\alpha}{\alpha}\right) & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*, \end{cases} \tag{7}$$

and the firms' profits are

$$(8)\qquad \pi = \begin{cases} \frac{\alpha v^2}{4t} & \text{for } v \le t, \\ \alpha\left(\frac{v}{2} - \frac{t}{4}\right) & \text{for } t < v \le 3t/2, \\ \frac{\alpha}{8t}\left(v + \frac{t}{2}\right)^2 & \text{for } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ t\frac{1}{2\alpha} & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases}$$

Proof. See Appendix A. ■

Proposition 1 specifies the platform's optimal fee in equation (6). Both when $v \le 3t/2$ and when $v > 3t/2$ and $\alpha \le \alpha^* \equiv 4t/(t + 2v)$, it is in the best interest of the platform to choose the ϕ that maximises the industry profit. The intuition is that with few type-$\mathcal{A}$ consumers, the firm's outside option of selling directly to consumers is not very valuable. Hence, the platform does not have to give up much to get the firm on board. It is therefore not worth distorting fees to lower the outside option. By contrast, for $v > 3t/2$ and $\alpha > \alpha^*$, deviation profit increases faster with ϕ than industry profit. As a result, the platform finds it optimal to distort ϕ below its industry-profit-maximising value.

Welfare. Welfare is the sum of profits and consumer surplus:

$$(9)\qquad W = \Pi + CS = 2\int_0^Q (v - tx)dx,$$

where $\Pi = 2\int_0^Q pdx$ and $CS = 2\int_0^Q (v - tx - p)dx$. Evaluating the equilibrium price $p(\phi)$, derived in Lemma 1, at the optimal fee ϕ^* stated in Proposition 1, we obtain the equilibrium price and quantity per firm,

$$(10)\qquad p = \begin{cases} \frac{v}{2} & \text{for } v \le t, \\ v - \frac{t}{2} & \text{for } t < v \le 3t/2; \text{ or } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ \frac{t(2-\alpha)}{\alpha} & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*, \end{cases} \quad Q = \begin{cases} \frac{v}{2t} & \text{for } v \le t, \\ \frac{1}{2} & \text{for } v > t, \end{cases}$$

from which we infer

$$(11)\qquad W = \begin{cases} \frac{3v^2}{4t} & \text{for } v \le t, \\ v - \frac{t}{4} & \text{for } v > t, \end{cases}$$

and

$$(12)\qquad CS = \begin{cases} \frac{v^2}{4t} & \text{for } v \le t, \\ \frac{t}{4} & \text{for } t < v \le 3t/2; \text{ or } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ v - \frac{2t}{\alpha} + \frac{3t}{4} & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases}$$

For $v < t$, firms are local monopolists and charge the monopoly price, $v/2$, even though the platform charges no fees ($\phi = 0$). At $v = t$, the market becomes covered, and firms switch to pricing at the limit price, $v - t/2$, that extracts all surplus from the marginal buyer, located at $x = 1/2$. As v increases above $3t/2$, the platform needs to support this outcome by introducing positive fees. For sufficiently large α, the platform sacrifices some industry profits to reduce the firms' outside option and, as a result, the price drops below $v - t/2$. Total surplus (W), however, is unaffected as the market remains covered and prices only affect how surplus is split among consumers, firms, and the platform.

IV(ii). *Revealing and Anonymous Channel*

We now move to the case in which the platform makes both a revealing and an anonymous sales channel available. In an equilibrium in which the prices on the anonymous channel are symmetric (i.e., $p_0^a = p_1^a = p^a$), a consumer who buys via the anonymous channel obtains, in expectation, $u^a = v - t/2 - p^a$. The utilities from purchasing via the revealing channel, u_0 and u_1, are the same as before. There exist cutoffs $\tilde{x}_0$ and $\tilde{x}_1$ such that consumers with $x < \tilde{x}_0$ buy from firm 0 and consumers with $x > \tilde{x}_1$ buy from firm 1 via the revealing channel, while consumers with $\tilde{x}_0 < x < \tilde{x}_1$ buy via the anonymous channel.[15] We have

$$\tilde{x}_0 = \frac{1}{2} - \frac{p_0^r - p^a}{t}, \qquad \tilde{x}_1 = \frac{1}{2} + \frac{p_1^r - p^a}{t}. \tag{13}$$

Figure 1 provides a graphical illustration of how demand is constructed. The figure depicts consumers' gross utility from buying through the revealing channel from firm 0 ($v - tx$) and firm 1 ($v - t(1 - x)$), the gross utility from buying through the revealing channel, $v - t/2$, and the prices, p^a and p^r, for a situation where both firms charge p^r on the revealing channel and p^a on the anonymous channel, with $p^a < v - t/2$ and $p^a < p^r < p^a + t/2$. A consumer who is closer to firm 0 than firm 1 (located at some $x < 1/2$) compares the utility from buying via the anonymous channel, u^a, given by the difference between $v - t/2$ and p^a, with the utility from buying via the revealing channel from firm 0, given by the difference between $v - tx$ and p^r. Because u^a is independent of the consumer's location while $u_0(x)$ decreases with x, with $u_0(0) > u^a$ and $u_0(1/2) < u^a$, there exists a consumer $\tilde{x}$, defined by $u_0(\tilde{x}) = u^a$, such that consumers with $x < \tilde{x}$ buy from firm 0 on the revealing channel while those with $\tilde{x} < x < 1/2$ buy on the anonymous channel. By symmetry,

[15] The conditions for these cutoffs to be interior, $0 \le \tilde{x}_0 \le \tilde{x}_1 \le 1$, are that $p_j^r \le p^a + t/2$, $j = 0, 1$, and $(p_0^r + p_1^r)/2 \ge p^a$. These conditions are taken into account when specifying the demand functions below and are satisfied in equilibrium.

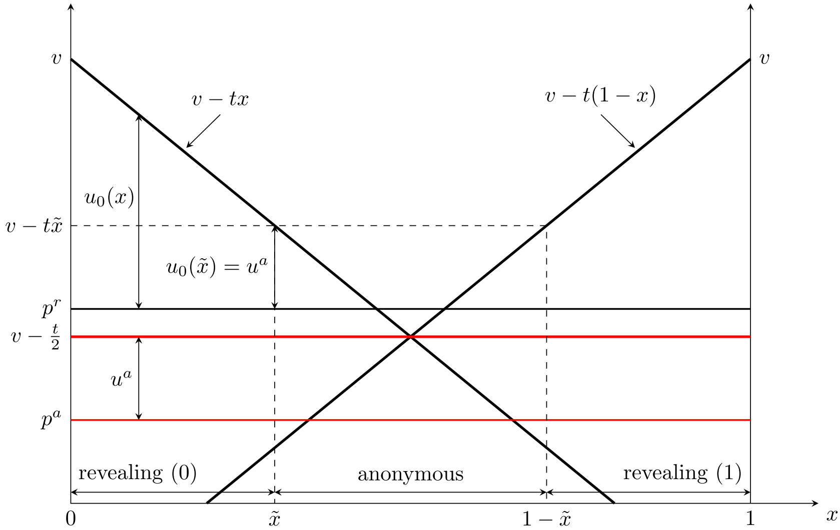

Figure 1
Demand for Given Symmetric Prices p^a and p^r

Notes: [Colour figure can be viewed at wileyonlinelibrary.com]

the same thing applies to consumers who are closer to firm 1 than firm 0, where the relevant cutoff is $1 - \tilde{x}$.

The analysis proceeds as follows. Lemma 2 derives the equilibrium price on the anonymous channel and shows that it depends only on the transaction fee on that channel, ϕ^a. Afterwards, we derive the demand on the revealing channel for given prices (p_0^r, p_1^r) and a given ϕ^a. Finally, we determine the equilibrium price on the revealing channel as a function of transaction fees (ϕ^a, ϕ^r).

Lemma 2. The symmetric equilibrium price on the anonymous channel is $p^a = \phi^a$.

Proof. See Appendix A. ■

The intuition behind Lemma 2 is that products appear homogeneous to consumers on the anonymous channel. Hence, Bertrand-like competition drives prices down to marginal cost.

It follows that a consumer buying through the anonymous channel obtains a surplus $u^a = v - t/2 - \phi^a$. Thus, the outside option for consumers on the revealing channel is $\max\{u^a, 0\}$.

Suppose $\phi^a > v - t/2$. Then, no consumer will ever buy via the anonymous channel and everything is exactly as in Section IV(i). Hence, in what follows, we focus on the case where $\phi^a \leq v - t/2$ and derive demand and equilibrium. Later, in the analysis of the platform's profit-maximising design and pricing behaviour, we allow ϕ^a to be either smaller or larger than $v - t/2$.

When $\phi^a \leq v - t/2$, the market is covered as all consumers always receive positive surplus when buying on the anonymous channel, $u^a \geq 0$. The demand for firm 0 via the revealing channel is q_0^r, given by

$$q_0^r(p_0^r, p_1^r) = \begin{cases} \frac{1}{2} + \frac{\phi^a - p_0^r}{t} & \text{for } p_0^r > 2\phi^a - p_1^r, \\ \frac{1}{2}\left(1 + \frac{p_1^r - p_0^r}{t}\right) & \text{for } p_0^r \leq 2\phi^a - p_1^r. \end{cases} \tag{14}$$

The firm's profit is $q_0^r(p_0^r - \phi^r) - F$ (it makes no profits on the anonymous channel). Maximising with respect to p_0^r and solving for a symmetric equilibrium, with $p_0^r = p_1^r = p^r$, we obtain the equilibrium price on the revealing channel as

$$p^r(\phi^a, \phi^r) = \begin{cases} \frac{t}{4} + \frac{\phi^a + \phi^r}{2} & \text{for } \phi^r \geq \phi^a - t/2, \\ \phi^a & \text{for } \phi^a - t \leq \phi^r < \phi^a - t/2, \\ t + \phi^r & \text{for } \phi^r < \phi^a - t. \end{cases} \tag{15}$$

The resulting equilibrium quantity sold via the revealing channel is

$$q^r(\phi^a, \phi^r) = \begin{cases} \frac{1}{4} + \frac{\phi^a - \phi^r}{2t} & \text{for } \phi^a - t/2 \leq \phi^r < \phi^a + t/2, \\ \frac{1}{2} & \text{for } \phi^r \leq \phi^a - t/2. \end{cases} \tag{16}$$

Using the fact that $\tilde{x}_0 = 1 - \tilde{x}_1 = q^r$ in any symmetric equilibrium, the platform's problem is $\max_{F,\phi^r,\phi^a} 2\left(q^r(\phi^a, \phi^r)\phi^r + (1/2 - q^r(\phi^a, \phi^r))\,\phi^a + F\right)$ subject to $F \leq (p^r(\phi^a, \phi^r) - \phi^r)q^r(\phi^a, \phi^r) - \pi_D(\phi^a, \phi^r)$.Since the constraint must be binding at the optimum, this simplifies to

$$\max_{\phi^r, \phi^a} \Pi(\phi^a, \phi^r) - 2\pi_D(\phi^a, \phi^r), \tag{17}$$

where Π denotes industry profits, given by

$$\begin{aligned} \Pi(\phi^a, \phi^r) &= 2q^r(\phi^a, \phi^r)p^r(\phi^a, \phi^r) + \left(1 - 2q^r(\phi^a, \phi^r)\right)\phi^a \\ &= \phi^a + 2q^r(\phi^a, \phi^r)(p^r(\phi^a, \phi^r) - \phi^a). \end{aligned} \tag{18}$$

Lemma 3 shows that the platform is always better off setting $\phi^a \leq v - t/2$.

Lemma 3. The industry profit Π computed at $\phi^a = v - t/2$ is (weakly) larger than for any $\phi^a > v - t/2$.

Furthermore, for a given ϕ^r, deviation profits π_D are weakly larger for $\phi^a > v - t/2$ than for $\phi^a \leq v - t/2$.

Proof. See Appendix A. ■

The result about the industry profit Π follows immediately from the fact that a change from $\phi^a > v - t/2$ to $\phi^a = v - t/2$ may push currently inactive consumers to purchase on the anonymous platform without affecting the incentives and behaviour of the consumers that were already active.

The result about the deviation profit π_D can be explained as follows. Suppose firm 0 deviates and rejects the platform's offer. By selling directly to consumers, firm 0 can only reach type-$\mathcal{A}$ buyers (a fraction α of the total). Consumers observe that only firm 1 is present on the revealing channel and correctly infer that the firm present on the anonymous channel is firm 1. Hence, they have full information regardless of which sales channel they purchase through. If they buy from firm 1, they use the sales channel where the product is cheaper.

Firm 0's deviation profit increases with the price p_1 charged by the rival, firm 1. Figure 2 shows how p_1 depends on the fees charged by the platform on the anonymous and revealing channel. It depicts p_1 on the vertical and ϕ^r on the horizontal axis. For $\phi^a > v - t/2$ (the black line), the anonymous channel is unattractive and everything is as if only the revealing channel were available, that is, the price of firm 1 is as stated in (2). For $\phi^a < v - t/2$ (the red line), what matters is the lowest of the prices on the anonymous and revealing channels, $p_1 = \min\{p^a, p^r\}$. For $\phi^r \leq \phi^a - t$, this is $p^r = t + \phi^r$. For $\phi^r > \phi^a - t$, it is $p^a = \phi^a$. As the figure shows, p_1 is always weakly greater when $\phi^a > v - t/2$.

Proposition 2 establishes that the platform prefers both channels to be active.

Proposition 2. It is profit maximising for the platform to set $\phi^r = \phi^a$, implying $\phi^a - t/2 < \phi^r < \phi^a + t/2$, so that both channels are active at the optimum. The platform earns strictly higher profit than with only the revealing channel active.

Proof. See Appendix A. ■

The proof of Proposition 2 can be sketched as follows. Fixing the non-deviating firm's price p_1, and thus the deviation profit π_D, all that matters to the platform is the industry profit. Since p_1 is equal to the lower of the anonymous and revealing-channel prices, there are two ways to achieve a given p_1: either $p^a > p^r$, in which case $p_1 = p^r$, or $p^a < p^r$, in which case $p_1 = p^a$. In the former case, all consumers buy via the revealing channel, and because p_1 pins down p^r it also pins down industry profits. In the latter case, p_1 pins down p^a but the platform can freely vary p^r (above p^a) by appropriately choosing ϕ^r. As the proof shows, for any given $p_1 \leq v - t/2$, there exist values of ϕ^r such that industry profit (and thus platform profit) is strictly higher

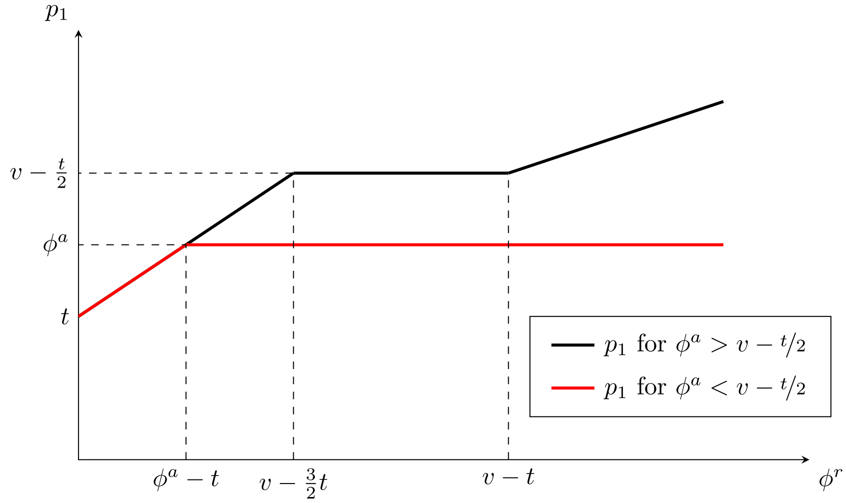

Figure 2
Non-Deviating Firm's Price as a Function of (ϕ^r, ϕ^a)

Notes: [Colour figure can be viewed at wileyonlinelibrary.com]

when both channels are active rather than only the revealing channel. The fee that maximises profits is $\phi^r = \phi^a$.

The intuition for this result is twofold. First, introducing the anonymous channel enables the platform to (induce firms to) charge higher prices to the consumers located close to the firms, who have the highest willingness to pay, without losing consumers towards the middle. Second, the presence of the anonymous channel decouples the deviation profit from the price on the revealing channel. In the absence of the anonymous channel, if the platform raises p^r (by raising ϕ^r), then deviation profits rise as well. By contrast, with both channels active, the platform can raise p^r without changing deviation profits. This is because deviation profits depend on the lower of the two prices, which (at the optimum) is p^a.

Since it is optimal to set $\phi^r = \phi^a \equiv \phi$, the platform's problem is to choose the common transaction fee ϕ that maximises $\Pi(\phi, \phi) - 2\pi_D(\phi, \phi)$. The following proposition describes the optimal fee.

Proposition 3. When both the revealing and anonymous sales channels are active, the platform's profit-maximising fee on both channels is

$$\phi^* = \begin{cases} v - \frac{t}{2} & \text{for } v \leq 3t/2; \text{ or } v > 3t/2 \text{ and } \alpha \leq \alpha^*, \\ t\left(\frac{2-\alpha}{\alpha}\right) & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases} \tag{19}$$

This implies that the platform's profit is

$$(20)\qquad \pi^P = \begin{cases} v - \frac{3t}{8} - \frac{\alpha v^2}{2t} & \text{for } v \le t, \\ (1-\alpha)\left(v - \frac{t}{2}\right) + \frac{t}{8} & \text{for } t < v \le 3t/2, \\ v - \frac{3t}{8} - \frac{\alpha}{4t}\left(v + \frac{t}{2}\right)^2 & \text{for } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ t\left(\frac{1-\alpha}{\alpha} + \frac{1}{8}\right) & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*, \end{cases}$$

and that the firms' profits are

$$(21)\qquad \pi = \begin{cases} \frac{\alpha v^2}{4t} & \text{for } v \le t, \\ \alpha\left(\frac{v}{2} - \frac{t}{4}\right) & \text{for } t < v \le 3t/2, \\ \frac{\alpha}{8t}\left(v + \frac{t}{2}\right)^2 & \text{for } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ t\frac{1}{2\alpha} & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases}$$

Proof. See Appendix A. ■

According to Proposition 3, when both sales channels are active the platform always charges positive per-unit fees. This contrasts with the case where only the revealing channel is active: there, the platform sometimes charges a per-unit fee of zero. There are two reasons for this. First, firms compete too fiercely on the anonymous channel, where their products appear homogeneous to consumers. Raising the per-unit fee pushes up the price on the anonymous channel and thus improves the extraction of consumer surplus. Second, firms do not take into account the revenue that the anonymous channel generates for the platform when setting prices on the revealing channel. The firms themselves make zero profit on the anonymous channel, so they set the price on the revealing channel too low from the point of view of industry profits.

Welfare. Welfare is the sum of profits and consumer surplus:

$$(22)\qquad W = \Pi + CS = 2\left(\int_0^{Q^r} (v - tx)dx + Q^a\left(v - \frac{t}{2}\right)\right),$$

where Q^r and Q^a respectively denote the quantities sold via the revealing and anonymous channels by each firm, while the industry profit is $\Pi = 2(p^r Q^r + p^a Q^a)$ and consumer surplus is $CS = 2\int_0^{Q^r}(v - tx - p^r)dx + Q^a\left(v - \frac{t}{2} - p^a\right)$.

Using the fact that $\phi^r = \phi^a$ (Proposition 2) and, thus, $Q^r = Q^a = 1/4$ regardless of v and α, we obtain that when both channels are active welfare is the same irrespective of which region of the parameter space we are in:

$$W = 2\left(\left[vx - t\frac{x^2}{2}\right]_0^{1/4} + \frac{1}{4}\left(v - \frac{t}{2}\right)\right) = v - \frac{5}{16}t. \tag{23}$$

Consumer surplus is

$$\begin{aligned} CS &= 2\left[(v - p^r)x - t\frac{x^2}{2}\right]_0^{1/4} + \frac{1}{2}\left(v - \frac{t}{2} - p^a\right) \\ &= \frac{v - p^r}{2} - \frac{t}{16} + \frac{1}{2}\left(v - \frac{t}{2} - p^a\right). \end{aligned} \tag{24}$$

Using ϕ^* from Proposition 3, the equilibrium prices on the revealing and anonymous channel are

$$(p^r, p^a) = \begin{cases} \left(v - \frac{t}{4}, v - \frac{t}{2}\right) & \text{for } v \le 3t/2; \text{ or } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ \left(t\left(\frac{2-\alpha}{\alpha} + \frac{1}{4}\right), t\left(\frac{2-\alpha}{\alpha}\right)\right) & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases} \tag{25}$$

Using equation (25) to replace p^r and p^a in equation (24), we obtain

$$CS = \begin{cases} \frac{t}{16} & \text{for } v \le 3t/2; \text{ or } v > 3t/2 \text{ and } \alpha \le \alpha^*, \\ v - \left(\frac{2}{\alpha} - \frac{9}{16}\right)t & \text{for } v > 3t/2 \text{ and } \alpha > \alpha^*. \end{cases} \tag{26}$$

Figure 3 depicts total surplus when both sales channels are active for the case where $v > 3t/2$ and $\alpha > \alpha^*$. Consumers at locations $x < 1/4$ buy via the revealing channel from firm 0, generating total surplus $v - tx$, of which p^r is shared between the platform and firms while $v - tx - p^r$ goes to the consumer. Consumers at locations $x > 3/4$ behave in an analogous way.[16] The total surplus generated via the revealing channel is given by the grey-shaded area.

Consumers at intermediate locations, $1/4 < x < 3/4$, buy via the anonymous channel, generating expected total surplus $v - t/2$, of which p^a goes to the platform and $v - t/2 - p^a$ goes to the consumer. The total surplus generated via the anonymous channel is given by the pink-shaded area. Note that consumers who buy via the anonymous channel generate less total surplus than if they had bought via the revealing channel since $v - t/2 \le \max\{v - tx, v - t(1 - x)\}$, with strict inequality for $x \ne 1/2$. This is because these consumers sometimes (half the time, to be precise) do not end

[16] They buy from firm 1, generating surplus $v - t(1 - x)$, of which they keep $v - t(1 - x) - p^r$.

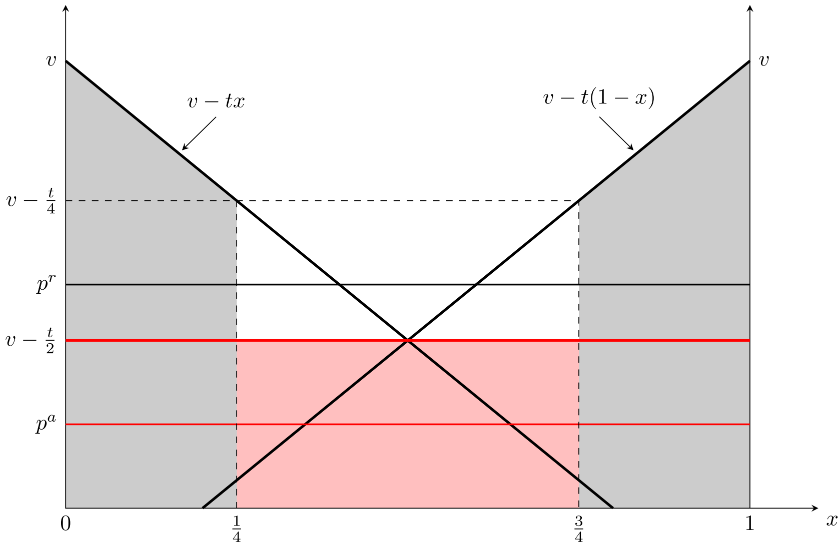

Figure 3
Total Surplus on Revealing and Anonymous Sales Channel

Notes: [Colour figure can be viewed at wileyonlinelibrary.com]

up with the closest of the two firms but, instead, get sent to the one that is further away from their location.

IV(iii). *Comparison*

Profits. We start by comparing the platform's profits. From inspection of the profit expressions in equations (7) and (20), it is straightforward to see that, for $v > t$, platform profits with both an anonymous and a revealing sales channel exceed those with only a revealing channel by $t/8$. For $v \leq t$, the condition for platform profits to be higher with both channels is $v - 3t/8 \geq v^2/2t \quad \Leftrightarrow v^2 - 2vt + 3t^2/4 \leq 0$. This inequality is satisfied for $v \in [t/2, 3t/2]$. Hence, the platform always benefits from introducing the anonymous sales channel under the maintained assumption that $v \geq t/2$.

Next, we compare the surplus captured by the firms. From inspection of equations (8) and (21), the firms' profits are identical with and without the anonymous platform.

Consumer surplus and welfare. Consumer surplus is given by equation (12) for the case where only the revealing sales channel is active and by equation (24) for the case where both channels are active. Proposition 4 compares them.

Proposition 4. Consumers are always better off when only the revealing sales channel is active.

Proof. See Appendix A. ■

The result in Proposition 4 is unequivocal: consumer surplus is always larger when only the revealing channel is active. When both channels are active, consumers who buy via the revealing channel pay a higher price than they would in the absence of the anonymous channel. From equations (10) and (25) it is readily seen that the revealing price is larger when both channels are active than when only the revealing channel is active. Although the presence of the anonymous channel sometimes (for $v < t$) enables consumers who would have otherwise remained out of the market to obtain the product, these consumers do not receive any surplus since it is completely extracted by the platform. The only case where consumers receive positive surplus on the anonymous channel is when $v > 3t/2$ and $\alpha > \alpha^*$. But in that parameter range, the market is covered even in the absence of the anonymous channel and the equilibrium price is the same ($t(2-\alpha)/\alpha$). Thus, the only difference is that consumers have lower expected travel costs when they buy via the revealing channel (since anonymity implies they do not always get sent to the closest seller).

Welfare is given by equation (11) for the case where only the revealing sales channel is active and by equation (23) for the case where both channels are active. Proposition 5 compares them.

Proposition 5. Compared to the case where only the revealing sales channel is available on the platform, the presence of both a revealing and an anonymous sales channel increases total welfare when $v \in [t/2, 5t/6]$ and decreases it otherwise.

Proof. See Appendix A. ■

Since $v < t/2$ is excluded by assumption, Proposition 5 shows that welfare is larger with only the revealing channel than with both if and only if $v > 5t/6$. To understand this result, consider first the case in which the market is covered even when only the revealing channel is available, that is, $v > t$. With a revealing channel only, the equilibrium price is less than or equal to $v - t/2$ and all consumers buy from the closest seller. By contrast, with both channels, only consumers at the extremities of the Hotelling line (with $x < 1/4$ or $x > 3/4$) buy from the closest seller; the remaining consumers, at intermediate locations ($1/4 < x < 3/4$), buy via the anonymous channel and thus end up at the closest seller only half the time. The loss of information associated with the anonymous design results in a welfare reduction as travel costs for these consumers are inefficiently high.

Now consider the case in which the market is not fully covered when only the revealing channel is available ($v \leq t$). In that case, a trade-off arises, as illustrated in Figure 4. Total surplus from consumers located on $[0, 1/4]$ and

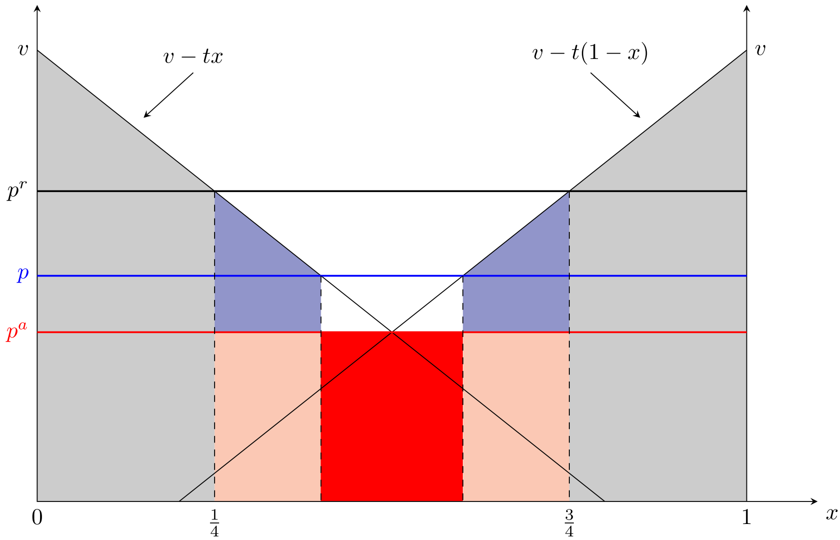

Figure 4
Total Surplus Comparison (Revealing Only Versus Both Channels)

Notes: [Colour figure can be viewed at wileyonlinelibrary.com]

$[3/4, 1]$ is the same in both cases, given by the grey-shaded area below the $v - tx$ and $v - t(1-x)$ lines.[17] For consumers in the intermediate range who buy when only the revealing channel is active—those for which $\max\{v - tx, v - t(1-x)\} \geq p$—total surplus is larger in the absence of the anonymous channel. This is because when both channels are active these consumers buy via the anonymous channel and, due to the information loss that leads to an inefficient allocation of buyers to sellers, generate less total surplus than they would on the revealing channel. The difference is given by the blue-shaded area.

For consumers who do not buy when only the revealing channel is active—those for which $\max\{v - tx, v - t(1-x)\} < p$, located toward the middle of the Hotelling line—total surplus is larger in the presence of the anonymous channel, as illustrated by the red-shaded area: they now get to consume the good, albeit at a price $p^a = v - t/2$ that extracts all their surplus. The anonymous channel thus leads to market expansion. The net effect of introducing the anonymous channel on total surplus is positive if the market-expansion effect outweighs the information-loss effect. This is the

[17] Under the assumption that $v \geq t/2$, consumers with $x \in [0, 1/4]$ or $x \in [3/4, 1]$ will always buy in equilibrium, even when only the revealing channel is active. Formally, $\tilde{x} = (v - p)/t = v/2t \geq 1/4 \Leftrightarrow v \geq t/2$ for $p = v/2$.

case for $v \leq 5t/6$. For $v > 5t/6$, the opposite is the case, and the anonymous channel reduces welfare.

V. DISCUSSION

V(i). *No Fixed Fees*

The analysis in the previous sections assumes that the platform offers a two-part tariff to firms. Here we discuss how our results are affected if the platform cannot use fixed fees and has to rely exclusively on transaction fees. While the platform would be better off using a two-part tariff, there are circumstances in which it may be difficult or impossible to charge substantial fixed fees. For example, firms may differ in profitability, which may not be observable to the platform. A high fixed fee would then drive away many firms, reducing the platform's attractiveness. The platform may prefer to use only transaction fees.[18] Note also that the optimal fixed fee can be negative for some parameter configurations. In practice, a negative fixed fee may cause the platform to haemorrhage money to firms that pretend to offer products for sale but never actually sell anything and thus never pay transaction fees. In that case, the best the platform can do is to set the fixed fee to zero and use only transaction fees.

Without fixed fees, the platform has to use transaction fees both for the purpose of controlling prices and for the purpose of extracting surplus. It suffers from a double-marginalisation problem: because firms do not take into account the revenue of the platform, the parties' combined markups exceed those that would maximise joint profits.

As we show in Appendix B, introducing the anonymous channel then helps the platform extract rents from firms in a different way. On the anonymous channel, the firms' products appear homogeneous to consumers, causing the firms to compete fiercely on price. This enhanced competition drives the firms' markups down to zero and eliminates the double-marginalisation problem for the subset of consumers who buy via the anonymous channel. As a result, on the anonymous channel the platform is able to extract the entire industry profit despite the fact that it can only use transaction fees. We also show that the platform finds it optimal to divert more consumers to the anonymous channel than when it can use fixed fees. It achieves this by raising transaction fees on the revealing channel and thus pushing up equilibrium prices there, while keeping fees and prices on the anonymous channel the same.

At the same time, our results on the consumer-surplus and welfare impact of introducing an anonymous channel are qualitatively unchanged. The anonymous channel unambiguously reduces consumer surplus. It increases

[18] Transaction fees do not have the same effect as fixed fees as they enter firms' marginal costs and may, therefore, be passed on to consumers.

welfare if transport costs are relatively large and otherwise reduces welfare. These results are driven by the same trade-off between information loss and market expansion that we identified in the baseline model.

V(ii). *Platform Competition*

Our model features a single platform, which has a monopoly on intermediation services. As we show, in this setting, all the additional industry profit generated by the anonymous channel is captured by the platform. Consumers are worse off and firms are either indifferent (in the baseline model) or worse off (in the extension without fixed fees studied in Appendix B). We now discuss how we expect results to change under platform competition.

The presence of competing platforms is likely to change how surplus is shared between the platforms and their users, presumably to the detriment of the former and to the benefit of the latter. It is conceivable that the introduction of an anonymous sales channel could make both firms and consumers better off. Competition will tend to put pressure on fixed fees and force platforms to share with firms some of the gains from introducing the anonymous channel. It is also possible that competition would force platforms to lower transaction fees, in which case the anonymous channel could end up benefitting consumers.

Although the distributional effects of the anonymous channel may be sensitive to the degree of platform competition, we conjecture that platforms would continue to have incentives to offer an anonymous channel and that the welfare effects we have derived are robust. The anonymous channel makes it possible to price discriminate, and an individual platform will benefit from the enhanced ability to extract surplus that this provides.[19] Moreover, the key forces we identified as driving the welfare effects of the anonymous channel are unchanged: as long as some consumers buy via the anonymous channel, there is an information loss which leads to inefficiency, and as long as prices on the anonymous channel are lower than elsewhere, there can be market expansion. Therefore, it seems plausible that the trade-off between information loss and market expansion persists under platform competition and that the overall welfare effect continues to depend on transport costs, which govern the relative importance of each of those forces.

VI. CONCLUSION

Online platforms that aggregate information and intermediate between consumers and firms play a key role in improving the quality of matches when products are differentiated and consumers have heterogeneous tastes.

[19] Collectively, the platforms may be worse off because price discrimination can increase the intensity of competition (Stole [2007]).

Yet, some of these platforms—which we refer to as anonymous—withhold information that is critical for efficient matching, namely on the firms' location. Although the anonymous platform design may be partly motivated by a desire to prevent the practice of showrooming, the fact that the leading players in the online travel industry hold in their portfolio both revealing and anonymous platforms suggests that the rationale for this design choice is more subtle. As we argue in this paper, it may be part of a broader strategy to boost rent extraction.

We develop a model in which horizontally differentiated firms sell to heterogeneous consumers both directly and indirectly through a platform. The platform chooses whether to adopt a design with only a revealing sales channel or one with both a revealing and an anonymous channel. We study how profits and welfare depend on the platform's design choice.

The platform is free for consumers, while firms pay for its intermediation services. An immediate benefit for firms is that the platform is able to reach more potential consumers. To avoid showrooming, the platform imposes a price-parity clause that prevents firms from undercutting the platform price when selling directly. We consider a two-part tariff structure (Appendix B studies the case of linear pricing) and show how the fixed fee is used to extract surplus, while the transaction fee can indirectly control prices. Rent extraction by the platform is limited by firms' outside option (direct sales), which in turn depends on the presence of an anonymous sales channel. In particular, we identify the conditions under which the platform chooses a transaction fee that does not maximise industry profits.

On the anonymous channel, consumers perceive differentiated products as identical, sparking Bertrand-like competition. However, the platform can maintain prices above marginal cost through transaction fees. Moreover, although anonymity reduces the surplus from trade, the presence of the anonymous channel allows the platform to push up prices to high-valuation consumers on the revealing channel without losing low-valuation consumers.

We find that introducing an anonymous sales channel is always profitable for the platform. This is both because the anonymous channel increases the size of the pie and because it increases the share of the pie that the platform can extract. Specifically, the anonymous channel allows for price discrimination, which increases industry profits, but it also leads to a decoupling of the firms' outside option from the price on the revealing channel, which improves rent extraction. When the platform has to rely on linear pricing rather than two-part tariffs, the anonymous channel has the additional effect of reducing double marginalisation, which also enhances the platform's ability to extract rents.

Perhaps surprisingly, the anonymous channel always harms consumers: on the one side, the quality of matches decreases, on the other the platform extracts more surplus. The effects on total welfare are more nuanced. In particular, there may be an increase in total welfare when the benefits from market expansion offset the costs of information loss.

Formally, our model relies on the assumption that the platform is able to use a price-parity clause. Absent such a clause, consumers would not buy via the revealing channel in our model: they would search on the platform and then buy more cheaply via the firms' direct channel. The platform would respond by offering only an anonymous channel. It is worth pointing out, however, that in practice platforms have a variety of other ways to incentivise firms not to undercut the platform price (e.g. by manipulating the ranking of search results).

Our work has important policy implications. Market regulators should carefully ponder the desirability of permitting anonymous platforms. They may also want to take into account how other, seemingly unrelated policies affect platforms' incentives to use revealing or anonymous sales channels. For example, more restrictive regulation of price parity clauses may have the unintended side-effect of driving platforms towards greater reliance on anonymous sales channels, with potentially deleterious consequences for the efficiency of matching in these markets.

APPENDIX A

PROOFS

Proof of Lemma 1. From the firm's profit we obtain the FOC

$$\frac{\partial q_0}{\partial p_0}(p_0 - \phi) + q_0 = 0. \tag{A.1}$$

We have

$$\frac{\partial q_0}{\partial p_0} = \begin{cases} -\frac{1}{t} & \text{if } p_0 > 2v - t - p_1, \\ -\frac{1}{2t} & \text{if } p_0 \leq 2v - t - p_1. \end{cases} \tag{A.2}$$

In a symmetric equilibrium, $p_0 = p_1 = p$. There are two candidates for an interior solution, solving (A.1), namely, $p = t + \phi$ and $p = (v + \phi)/2$:

- $p = t + \phi$ is an equilibrium if $p \leq 2v - t - p$ at $p = t + \phi$, that is, if $\phi \leq v - 3t/2$;
- $p = (v + \phi)/2$ is an equilibrium if $p > 2v - t - p$ at $p = (v + \phi)/2$, that is, if $\phi > v - t$.

For $v - 3t/2 < \phi \leq v - t$, neither of those is an equilibrium. In that case, the equilibrium is the corner solution $p = v - t/2$. Then, the marginal profit is $(p_0 - \phi)\partial q_0/\partial p_0 + q_0$ which, evaluated at $p_1 = v - t/2$, is positive for $p_0 < v - t/2$ and negative for $p_0 > v - t/2$. ■

Proof of Proposition 1. The proof includes two steps. We start by computing the deviation profit π_D and show how it depends on v, t, and ϕ. Then we compute the profit-maximising fee.

Step 1. The deviator's problem is

$$\max_{p_0} \alpha p_0 q_0(p_0, p(\phi)),$$

where q_0 is specified in (1). Thus, the deviator's optimal price is $p_0 = v/2$ if $v/2 > 2v - t - p(\phi) \Leftrightarrow p(\phi) > 3v/2 - t$, while it is $p_0 = (p(\phi) + t)/2$ if $(p(\phi) + t)/2 < 2v - t - p(\phi) \Leftrightarrow p(\phi) < 4v/3 - t$. For $4v/3 - t \leq p(\phi) \leq 3v/2 - t$, the optimal price is $p_0 = 2v - t - p(\phi)$. In what follows, we specify the deviation profits for the different regions of the parameter space.

Suppose first $v \leq t$. Then, $p(\phi) = (v + \phi)/2$ for all $\phi \geq 0$. Moreover, because $(v + \phi)/2 \geq v/2 \geq 3v/2 - t$, we have $p_0 = v/2$ and $\pi_D = \alpha v^2/4t$ irrespective of ϕ.

Next, suppose $t < v \leq 3t/2$. Then $p(\phi) = v - t/2$ for $\phi \in [0, v - t]$ and $p(\phi) = (v + \phi)/2$ for $\phi > v - t$. Moreover, $4v/3 - t \leq v - t/2 < 3v/2 - t$. Hence, for $\phi \leq v - t$, $p_0 = 2v - t - (v - t/2) = v - t/2$. For $\phi > v - t$, $p(\phi) = (v + \phi)/2$. There are two cases: if $(v + \phi)/2 \leq 3v/2 - t \Leftrightarrow \phi \leq 2(v - t)$, then $p_0 = 2v - t - (v + \phi)/2 = (3v - \phi)/2 - t$, while if $\phi > 2(v - t)$, then $p_0 = v/2$. Summarising, we have

$$(p_0, p_1) = \begin{cases} (v - t/2, v - t/2) & \text{for } 0 \leq \phi \leq v - t, \\ ((3v - \phi)/2 - t, (v + \phi)/2) & \text{for } v - t < \phi \leq 2(v - t), \\ (v/2, (v + \phi)/2) & \text{for } \phi > 2(v - t), \end{cases}$$

from which we infer

$$q_0 = \begin{cases} 1/2 & \text{for } 0 \leq \phi \leq v - t, \\ 1 - (v - \phi)/2t & \text{for } v - t < \phi \leq 2(v - t), \\ v/2t & \text{for } \phi > 2(v - t), \end{cases}$$

and

$$\pi_D = \begin{cases} \alpha(v/2 - t/4) & \text{for } 0 \leq \phi \leq v - t, \\ \alpha((3v - \phi)/2 - t)(1 - (v - \phi)/2t) & \text{for } v - t < \phi \leq 2(v - t), \\ \alpha v^2/4t & \text{for } \phi > 2(v - t). \end{cases}$$

Finally, suppose $v > 3t/2$. Notice that this implies $v - t/2 \leq 4v/3 - t$. Thus, for $\phi \leq v - 3t/2$, we have $p(\phi) = t + \phi$ and $p_0 = (p(\phi) + t)/2 = t + \phi/2$. For $v - 3t/2 < \phi \leq v - t$, we have $p(\phi) = v - t/2$ and $p_0 = v/2 + t/4$. For $\phi > v - t$, $p(\phi) = (v + \phi)/2$. There are three cases: if $(v + \phi)/2 \leq 4v/3 - t \Leftrightarrow \phi \leq 5v/3 - 2t$, then $p_0 = (p(\phi) + t)/2 = (v + \phi)/4 + t/2$; if $4v/3 - t < (v + \phi)/2 \leq 3v/2 - t \Leftrightarrow 5v/3 - 2t < \phi \leq 2(v - t)$, then $p_0 = 2v - t - p(\phi) = (3v - \phi)/2 - t$; if $(v + \phi)/2 > 3v/2 - t$, then $p_0 = v/2$.

Summarising the case where $v > 3t/2$, we have

$$(p_0, p_1) = \begin{cases} (t + \phi/2, t + \phi) & \text{for } 0 \leq \phi \leq v - 3t/2, \\ (v/2 + t/4, v - t/2) & \text{for } v - 3t/2 < \phi \leq v - t, \\ ((v + \phi)/4 + t/2, (v + \phi)/2) & \text{for } v - t < \phi \leq 5v/3 - 2t, \\ ((3v - \phi)/2 - t, (v + \phi)/2) & \text{for } 5v/3 - 2t < \phi \leq 2(v - t), \\ (v/2, (v + \phi)/2) & \text{for } \phi > 2(v - t), \end{cases}$$

from which we infer

$$q_0 = \begin{cases} 1/2 + \phi/4t & \text{for } 0 \le \phi \le v - 3t/2, \\ 1/2 + (v - 3t/2)/4t & \text{for } v - 3t/2 < \phi \le v - t, \\ 1/4 + (v + \phi)/8t & \text{for } v - t < \phi \le 5v/3 - 2t, \\ 1 - (v - \phi)/2t & \text{for } 5v/3 - 2t < \phi \le 2(v - t), \\ v/2t & \text{for } \phi > 2(v - t), \end{cases}$$

and

$$\pi_D = \begin{cases} \alpha(t + \phi/2)(1/2 + \phi/4t) & \text{for } 0 \le \phi \le v - 3t/2, \\ \alpha(v/2 + t/4)(1/2 + (v - 3t/2)/4t) & \text{for } v - 3t/2 < \phi \le v - t, \\ \alpha((v + \phi)/4 + t/2)(1/4 + (v + \phi)/8t) & \text{for } v - t < \phi \le 5v/3 - 2t, \\ \alpha((3v - \phi)/2 - t)(1 - (v - \phi)/2t) & \text{for } 5v/3 - 2t < \phi \le 2(v - t), \\ \alpha v^2/4t & \text{for } \phi > 2(v - t). \end{cases}$$

Therefore, we conclude that, if $v \le t$,

$$\pi_D = \alpha v^2/4t, \tag{A.3}$$

if $t < v \le 3t/2$,

$$\pi_D = \begin{cases} \alpha\left(\frac{v}{2} - \frac{t}{4}\right) & \text{for } 0 \le \phi \le v - t, \\ \alpha\left(\frac{(3v-\phi)}{2} - t\right)\left(1 - \frac{(v-\phi)}{2t}\right) & \text{for } v - t < \phi \le 2(v - t), \\ \frac{\alpha v^2}{4t} & \text{for } \phi > 2(v - t), \end{cases} \tag{A.4}$$

and if $v > 3t/2$,

$$\pi_D = \begin{cases} \alpha(t + \frac{\phi}{2})\left(\frac{1}{2} + \frac{\phi}{4t}\right) & \text{for } 0 \le \phi \le v - 3t/2, \\ \alpha\left(\frac{v}{2} + \frac{t}{4}\right)\left(\frac{1}{2} + \frac{(v-3t/2)}{4t}\right) & \text{for } v - 3t/2 < \phi \le v - t, \\ \alpha\left(\frac{(v+\phi)}{4} + \frac{t}{2}\right)\left(\frac{1}{4} + \frac{(v+\phi)}{8t}\right) & \text{for } v - t < \phi \le 5v/3 - 2t, \\ \alpha\left(\frac{(3v-\phi)}{2} - t\right)\left(1 - \frac{(v-\phi)}{2t}\right) & \text{for } 5v/3 - 2t < \phi \le 2(v - t), \\ \frac{\alpha v^2}{4t} & \text{for } \phi > 2(v - t). \end{cases} \tag{A.5}$$

Step 2. We can now proceed computing the profit-maximising ϕ.

For $v \le t$, the industry profit-maximising price is $p = v/2$, which implies that each firm sells $Q(p) = v/2t \le 1/2$. The platform can implement this by setting $\phi = 0$. Deviation profits are $\pi_D = \alpha v^2/4t$ irrespective of ϕ, so the platform's profit is $\pi^P = (1 - \alpha)v^2/2t$.

For $v > t$, the industry profit-maximising price is $p = v - t/2$, which implies that each firm sells $Q(p) = 1/2$. The platform can implement this by setting

$\phi \in [v - 3t/2, v - t]$. Notice that deviation profits in *step 1* are (weakly) increasing in ϕ. Hence, when $t < v \leq 3t/2$ it is optimal for the platform to set $\phi = 0$ (noting that $v - 3t/2 < 0 < v - t$). We then have $\pi_D = \alpha(v/2 - t/4)$ and the platform's profit is $\pi^P = (1 - \alpha)(v - t/2)$.

When $v > 3t/2$, the platform will never choose $\phi > v - 3t/2$. For $\phi \leq v - 3t/2$, industry profit is $\Pi = (t + \phi)$ and deviation profit is $\pi_D = \alpha(t + \phi/2)(1/2 + \phi/4t)$. Noticing that $\Pi' = 1$ and $\pi'_D = \alpha\,(1/2 + \phi/4t)$, two cases might arise, depending on the share α of type-$\mathcal{A}$ consumers. Indeed, at $\phi = v - 3t/2$ we have that $2\pi'_D > \Pi'$ if and only if $2\alpha\,(1/2 + (v - 3t/2)/4t) > 1$, which simplifies to

$$\alpha > \frac{4t}{t + 2v} \equiv \alpha^*. \tag{A.6}$$

If $\alpha \leq \alpha^*$, industry profit increases faster with ϕ than deviation profit (i.e. $\Pi' > 2\pi'_D$ for all $\phi \leq v - 3t/2$). In that case, the platform sets the fee at the industry-profit maximising value, $\phi^* = v - 3t/2$. The platform's profit then is $\pi^P = v - \frac{t}{2} - \frac{\alpha}{4t}\left(v + \frac{t}{2}\right)^2$.

If instead $\alpha > \alpha^*$, then $\Pi' \geq 2\pi'_D$ at $\phi = 0$ but $\Pi' < 2\pi'_D$ at $\phi = v - 3t/2$. By continuity, there exists $\hat{\phi} \in [0, v - 3t/2]$ such that deviation profits increase faster than industry profits for $\phi > \hat{\phi}$, and as a result, the platform finds it optimal to distort ϕ below its industry profit-maximising value and chooses ϕ solving $\Pi' = 2\pi'_D$ or $\phi^* = 2t\left(\frac{1-\alpha}{\alpha}\right)$. ■

Proof of Lemma 2. Let (p^a, p^r) be a symmetric equilibrium, with $p^a < p^r$, and suppose to the contrary that $p^a > \phi^a$. Then $\tilde{x}_0 = 1 - \tilde{x}_1 = \tilde{x} = 1/2 - (p^r - p^a)/t$, and firm 0 earns

$$\pi_0 = (p^r - \phi^r)\tilde{x} + (p^a - \phi^a)\left(\frac{1}{2} - \tilde{x}\right).$$

Consider a deviation by firm 0 to $(p_0^a, p_0^r) = (p^a - \varepsilon, p^r - \varepsilon)$, where $\varepsilon > 0$. Notice that $\tilde{x}_0$ is left unchanged by this deviation, $\tilde{x}_0^D = \tilde{x}$, while $\tilde{x}_1$ becomes $\tilde{x}_1^D = 1/2 + (p^r - (p^a - \varepsilon))/t$. Firm 0's deviation profit is

$$\pi_D = (p^r - \phi^r - \varepsilon)\tilde{x} + (p^a - \phi^a - \varepsilon)(\tilde{x}_1^D - \tilde{x}). \tag{A.7}$$

The deviation is profitable if $\pi_D - \pi_0 > 0$, or

$$(p^a - \phi^a - \varepsilon)\left(\tilde{x}_1^D - \frac{1}{2}\right) > \frac{\varepsilon}{2}. \tag{A.8}$$

As ε tends to zero, the right-hand side approaches zero while, because $\tilde{x}_1^D > 1/2$, the left-hand side is strictly positive for any $p^a > \phi^a$, a contradiction with (p^a, p^r) constituting an equilibrium. ■

Proof of Lemma 3. Lemma 3 includes two statements. The first statement is that industry profit Π weakly increases when lowering the fee on the anonymous channel from $\phi^a > v - t/2$ to $\phi^a = v - t/2$. This follows from the fact that any previously inactive consumers will then buy via the anonymous channel, while active consumers' behaviour remains unchanged.

The second statement is that the deviation profit π_D is weakly larger when $\phi^a > v - t/2$ than when $\phi^a = v - t/2$. To establish this claim, we now show that π_D increases with the price charged by the non-deviating firm, denoted p_1. Then, we show that fixing ϕ^r, p_1 is weakly greater for ϕ^a above $v - t/2$ than below.

Suppose firm 0 deviates while firm 1 charges p_1. Let $\pi_D(p_1)$ denote the value function of firm 0's problem, that is,

$$\pi_D(p_1) = \max_{p_0} \alpha p_0 q_0(p_0, p_1). \tag{A.9}$$

where

$$q_0(p_0, p_1) = \begin{cases} \frac{1}{2} + \frac{p_1 - p_0}{2t} & \text{for } p_0 \leq 2v - t - p_1, \\ \frac{v - p_0}{t} & \text{for } p_0 > 2v - t - p_1. \end{cases} \tag{A.10}$$

Solving firm 0's problem yields the optimal deviation price:

$$p_D = \begin{cases} \frac{p_1 + t}{2} & \text{for } p_1 \leq \frac{4}{3}v - t, \\ 2v - t - p_1 & \text{for } \frac{4}{3}v - t < p_1 \leq \frac{3}{2}v - t, \\ \frac{v}{2} & \text{for } p_1 > \frac{3v}{2} - t, \end{cases} \tag{A.11}$$

with associated demand (from type-$\mathcal{A}$ consumers)

$$q_D = \begin{cases} \frac{p_1 + t}{4t} & \text{for } p_1 \leq \frac{4}{3}v - t, \\ \frac{p_1 + t - v}{t} & \text{for } \frac{4}{3}v - t < p_1 \leq \frac{3}{2}v - t, \\ \frac{v}{2t} & \text{for } p_1 > \frac{3}{2}v - t. \end{cases} \tag{A.12}$$

From this we infer

$$\pi_D = \begin{cases} \frac{\alpha(p_1 + t)^2}{8t} & \text{for } p_1 \leq \frac{4}{3}v - t, \\ \frac{\alpha(p_1 + t - v)(2v - t - p_1)}{t} & \text{for } \frac{4}{3}v - t < p_1 \leq \frac{3}{2}v - t, \\ \frac{\alpha v^2}{4t} & \text{for } p_1 > \frac{3}{2}v - t, \end{cases} \tag{A.13}$$

Notice that $\pi_D(p_1)$ is continuously differentiable over the range $[0, 3v/2 - t)$. In particular, we have $\pi'_{D-}(4v/3 - t) = \pi'_{D+}(4v/3 - t) = \alpha v/3t$. Hence, we can apply the envelope theorem to obtain

$$\pi'_D(p_1) = \alpha p_0 \frac{\partial q_0}{\partial p_1} \geq 0, \tag{A.14}$$

where the inequality follows from $\partial q_0/\partial p_1 \geq 0$. To establish that π_D increases with ϕ^a, it thus suffices to show that p_1 increases with ϕ^a.

For $\phi^a > v - t/2$, p_1 is given by Lemma 1. For $\phi^a \leq v - t/2$, $p_1 = \min\{p^a, p^r\}$, where $p^a = \phi^a$ by Lemma 2 and p^r is given by (15). Since, for $\phi^a \leq v - t/2$, we have $\phi^a - t \leq v - 3t/2$, the claim follows. ■

Proof of Proposition 2. Fix $p_1 = \overline{p}$. By Lemma 3 it is optimal for the platform to set $\phi^a \leq v - t/2$. Since p_1 is capped by ϕ^a in that case, we can restrict attention to $\overline{p} \leq v - t/2$.

Recall from the proof of Lemma 3 that, for $\phi^a \leq v - t/2$, $p_1 = \min\{p^a, p^r\}$ given by

$$\min\{p^a, p^r\} = \begin{cases} \phi^a & \text{for } \phi^a - \phi^r \leq t, \\ t + \phi^r & \text{for } \phi^a - \phi^r > t. \end{cases} \tag{A.15}$$

Hence, there are two ways to implement $p_1 = \overline{p}$: either $\phi^a = \overline{p} < \phi^r + t$, or $\phi^r + t = \overline{p} < \phi^a$. In both cases, π_D is the same. Hence, for a given $\overline{p}$, the platform's profit depends only on Π. Using equations (15) and (16) to replace p^r and q^r in equation (18), we obtain

$$\Pi = \phi^a + \begin{cases} \left(\frac{1}{2} + \frac{\phi^a - \phi^r}{t}\right)\left(\frac{t}{2} + \phi^r - \phi^a\right) & \text{for } \phi^a - \frac{t}{2} \leq \phi^r < \phi^a + \frac{t}{2}, \\ \underbrace{(\phi^a - \phi^a)}_{=0} & \text{for } \phi^a - t \leq \phi^r < \phi^a - \frac{t}{2}, \\ (t + \phi^r - \phi^a) & \text{for } \phi^r < \phi^a - t. \end{cases} \tag{A.16}$$

If $\phi^a = \overline{p} < \phi^r + t$, we have

$$\Pi = \begin{cases} \overline{p} + \Delta(\phi^r) & \text{for } \overline{p} - \frac{t}{2} \leq \phi^r < \overline{p} + \frac{t}{2}, \\ \overline{p} & \text{for } \overline{p} - t \leq \phi^r < \overline{p} - \frac{t}{2}, \end{cases} \tag{A.17}$$

where

$$\Delta(\phi^r) = \frac{t}{2}\left(\frac{1}{2} + \frac{\overline{p} - \phi^r}{t}\right)\left(\frac{1}{2} - \frac{\overline{p} - \phi^r}{t}\right) = \frac{t}{2}\left(\frac{1}{4} - \left(\frac{\overline{p} - \phi^r}{t}\right)^2\right). \tag{A.18}$$

If $\phi^r + t = \overline{p} < \phi^a$, we have $\Pi = \overline{p}$.

To complete the proof, we now show that among all ϕ^r satisfying $\phi^a = \overline{p} < \phi^r + t$, the one that maximises the platform's profit is contained in $[\overline{p} - t/2, \overline{p} + t/2)$ and yields $\Delta(\phi^r) > 0$. The value of ϕ^r that maximises Δ for a given $\overline{p}$ is the one that minimises $(\overline{p} - \phi^r)^2$, namely, $\phi^r = \overline{p} = \phi^a$. We have $\overline{p} - t/2 < \overline{p} < \overline{p} + t/2$ and $\Delta(\overline{p}) = t/8 > 0$ for any $t > 0$. Since all of this holds for any $\overline{p} \leq v - t/2$, we conclude that the platform's profit is maximised by setting $\phi^r = \phi^a$. ■

Proof of Proposition 3. For $\phi \leq v - t/2$ we have that

$$\Pi(\phi, \phi) = \phi + \frac{t}{8}. \tag{A.19}$$

Using equation (A.13), the deviation profit is:

$$\pi_D(\phi, \phi) = \begin{cases} \frac{\alpha(\phi + t)^2}{8t} & \text{for } \phi \leq 4v/3 - t, \\ \frac{\alpha(\phi + t - v)(2v - t - \phi)}{t} & \text{for } 4v/3 - t < \phi \leq 3v/2 - t, \\ \frac{\alpha v^2}{4t} & \text{for } \phi > 3v/2 - t. \end{cases} \tag{A.20}$$

We have $\Pi' = 1$ and

$$\pi'_D = \begin{cases} \frac{\alpha(\phi + t)}{4t} & \text{for } \phi \leq \frac{4}{3}v - t, \\ \frac{\alpha(3v/2 - t - \phi)}{2t} & \text{for } \frac{4}{3}v - t < \phi \leq \frac{3}{2}v - t, \\ 0 & \text{for } \phi > \frac{3}{2}v - t. \end{cases} \tag{A.21}$$

Notice that π'_D is increasing in ϕ over the first segment, decreasing over the second, and constant afterwards. Thus, the maximum of π'_D is attained at $\phi = 4v/3 - t$, where the left derivative is $\pi'_{D-}(4v/3 - t) = \alpha v/3t$ and the right derivative is $\pi'_{D+}(4v/3 - t) = \alpha v/12t < \alpha v/3t$. Hence, if $v/3t \leq 1/2 \Leftrightarrow v \leq 3t/2$, we always have $2\pi'_D < \Pi'$, so it is optimal to set ϕ as large as possible, implying $\phi = v - t/2$.

If $v > 3t/2$, then $v - t/2 < 4v/3 - t$, so we are always in the first segment of π_D. Notice that $2\pi'_D(0) = \alpha/2 < \Pi' = 1$. Thus it suffices to check whether $2\pi'_D(v - t/2) > \Pi'$, or

$$\frac{\alpha(v + t/2)}{2t} > 1 \quad \Leftrightarrow \quad \alpha > \frac{4t}{2v + t} = \alpha^*. \tag{A.22}$$

For $\alpha \leq \alpha^*$, we always have $2\pi'_D \leq \Pi'$, so $\phi = v - t/2$ is again optimal. For $\alpha > \alpha^*$, the solution is found by solving $2\pi'_D(\phi) = \Pi'(\phi)$, or

$$\frac{\alpha(\phi + t)}{2t} = 1, \tag{A.23}$$

yielding $\phi = t(2 - \alpha)/\alpha$.

We now derive the platform's profit. Suppose first $v \leq t$. Then, the optimal fee is $\phi = v - t/2$, and since $v - t/2 \geq 3v/2 - t \Leftrightarrow v \leq t$, we are in the last segment of π_D. Hence,

$$\pi^P = v - \frac{t}{2} + \frac{t}{8} - \frac{\alpha v^2}{2t}. \tag{A.24}$$

Next, suppose $t < v \leq 3t/2$. The optimal fee continues to be $\phi = v - t/2$ and we have $4v/3 - t \leq v - t/2 < 3v/2 - t$, so we are in the second segment of π_D. Thus,

$$\pi^P = v - \frac{t}{2} + \frac{t}{8} - \alpha\left(v - \frac{t}{2}\right) = (1 - \alpha)\left(v - \frac{t}{2}\right) + \frac{t}{8}. \tag{A.25}$$

Finally, suppose $v > 3t/2$. Then, $v - t/2 < 4v/3 - t$, so we are in the first segment of π_D. If $\alpha \leq \alpha^*$, the optimal fee is $\phi = v - t/2$, and we obtain

$$\pi^P = v - \frac{t}{2} + \frac{t}{8} - \frac{\alpha}{4t}\left(v + \frac{t}{2}\right)^2. \tag{A.26}$$

If $\alpha > \alpha^*$, the optimal fee is $\phi = t(2 - \alpha)/\alpha$, and

$$\pi^P = t\left(\frac{2 - \alpha}{\alpha}\right) + \frac{t}{8} - \frac{\alpha}{4t}\left(t\left(\frac{2 - \alpha}{\alpha}\right) + t\right)^2 = t\left(\frac{1 - \alpha}{\alpha} + \frac{1}{8}\right). \tag{A.27}$$

Finally, we compute the firms' profit. Since the platform holds firms down to their outside option, this is simply obtained by evaluating equation (A.20) at the optimal ϕ^*, which is defined by equation (19).

If $v \leq t$, then $\phi^* = v - t/2 \geq 3v/2 - t$ and hence $\pi = \frac{\alpha v^2}{4t}$. If $t < v \leq 3t/2$, then $\phi^* = v - t/2$ and $4v/3 - t < v - t/2 \leq 3v/2 - t$, implying $\pi = \alpha\left(\frac{v}{2} - \frac{t}{4}\right)$. If $v > 3t/2$ and $\alpha \leq \alpha^*$, then $\phi^* = v - t/2 \leq 3v/2 - t$ and hence $\pi = \frac{\alpha}{8t}\left(v + \frac{t}{2}\right)^2$. Finally, if $v > 3t/2$ and $\alpha > \alpha^*$, then $\phi^* = t\left(\frac{2-\alpha}{\alpha}\right) \leq 3v/2 - t$, implying $\pi = \frac{t}{2\alpha}$. ■

Proof of Proposition 4. For $v \leq t$, we have $\frac{v^2}{4t} \geq \frac{t}{16} \Leftrightarrow v \geq \frac{t}{2}$, which is satisfied by assumption. For $v > t$, it is immediate that $\frac{t}{4} > \frac{t}{16}$ and $v + \frac{3t}{4} - \frac{2t}{\alpha} > v + \frac{9t}{16} - \frac{2t}{\alpha}$. ■

Proof of Proposition 5. For $v \leq t$, we have $\frac{3v^2}{4t} > v - \frac{5}{16}t \Leftrightarrow v^2 - \frac{4t}{3}v + \frac{5}{12}t^2 > 0$, which is true if and only if $v < t/2$ or $v > 5t/6$. For $v > t$, it is immediate that $v - \frac{t}{4} > v - \frac{5}{16}t$. ■

APPENDIX B

NO FIXED FEES

In this appendix, we consider the case where the platform cannot use fixed fees. That is, in the game described in the model section, instead of offering a two-part tariff with fees (F, ϕ^a, ϕ^r) at stage 1, the platform offers a pair of fees (ϕ^a, ϕ^r). For brevity, we restrict attention to the case where $\alpha = 0$: there are no type-$\mathcal{A}$ consumers, so the firms' outside option is zero.

B(i). *Revealing Channel Only*

Suppose first that only the revealing channel is active. Because equilibrium prices do not depend on fixed fees, the result in Lemma 1 remains valid: for a given fee ϕ, the symmetric equilibrium price is

$$p(\phi) = \begin{cases} t + \phi & \text{for } \phi \leq v - 3t/2, \\ v - \frac{t}{2} & \text{for } v - 3t/2 < \phi \leq v - t, \\ \frac{(v+\phi)}{2} & \text{for } \phi > v - t. \end{cases} \tag{B.1}$$

It also continues to be true that the per-firm quantity in a symmetric equilibrium is

$$Q(p) = \begin{cases} \frac{v-p}{t} & \text{for } p > v - t/2, \\ \frac{1}{2} & \text{for } p \leq v - t/2. \end{cases} \tag{B.2}$$

The platform's problem is

$$\max_{\phi \leq v} 2\phi Q(p(\phi)). \tag{B.3}$$

There are two differences with respect to the baseline model: the platform does not earn revenue from fixed fees, and the firms' outside option is zero.[20] The following lemma characterises the optimal fee.

Proposition 6. If the platform uses only a revealing sales channel, the fee that maximises its profit is

$$\phi^* = \begin{cases} \frac{v}{2} & \text{for } v \leq 2t, \\ v - t & \text{for } v > 2t. \end{cases}$$

[20] In principle, the platform still needs to ensure that the participation constraint holds, that is, that firms make non-negative profits. However, $\pi = (p(\phi) - \phi)Q(p(\phi) \geq 0$ for $\phi \leq v$ since $p(\phi) > \phi$ for all ϕ and $Q(p) \geq 0$ for $p \leq v$. Hence, the participation constraint reduces to an upper bound on ϕ.

Proof. Using (B.1) and (B.2) we can write the platform's profit as

$$\text{(B.4)} \qquad \pi^P = \begin{cases} \phi & \text{for } \phi \leq v - t, \\ \phi\left(\frac{v-\phi}{t}\right) & \text{for } \phi > v - t. \end{cases}$$

Since π^P is increasing in ϕ up to $v - t$, there are two candidates: a corner solution at $\phi = v - t$, with $\pi^P = v - t$, and an interior solution at $\phi = v/2$, with $\pi^P = v^2/4t$. We have $v^2/4t \geq v - t \Leftrightarrow (v - 2t)^2 \geq 0$, so the interior solution prevails unless $v/2 < v - t$, or $v > 2t$. ∎

Proposition 6 implies that the platform's equilibrium profit is

$$\text{(B.5)} \qquad \pi^P = \begin{cases} \frac{v^2}{4t} & \text{for } v \leq 2t, \\ v - t & \text{for } v > 2t. \end{cases}$$

Equilibrium price and seller profit are given by

$$\text{(B.6)} \qquad p = \begin{cases} \frac{3}{4}v & \text{for } v \leq 2t, \\ v - \frac{t}{2} & \text{for } v > 2t, \end{cases} \qquad \pi = \begin{cases} \frac{v^2}{16t} & \text{for } v \leq 2t, \\ \frac{t}{4} & \text{for } v > 2t. \end{cases}$$

Compared to the situation analysed in the main text, here the price is always weakly higher. The intuition is that the platform faces a double-marginalisation problem: the firms do not take into account the effect of a price increase on the platform's revenue, and hence charge prices that are too high, from the platform's point of view. Both the platform and consumers are better off if the platform can correct the double-marginalisation problem by means of a two-part tariff.[21]

Welfare (total surplus) is the sum of platform profit, sellers' profit, and consumers surplus, $W = \pi^P + 2\pi + CS$. Noticing that $\pi^P + 2\pi = 2pQ(p)$ and $CS = (v - p)Q(p)$, we have $W = (v + p)Q(p)$. Using the expressions derived above, equilibrium consumer surplus and welfare are

$$\text{(B.7)} \qquad CS = \begin{cases} \frac{v^2}{16t} & \text{for } v \leq 2t, \\ \frac{t}{4} & \text{for } v > 2t, \end{cases} \qquad W = \begin{cases} \frac{7v^2}{16t} & \text{for } v \leq 2t, \\ v - \frac{t}{4} & \text{for } v > 2t. \end{cases}$$

B(ii). *Revealing and Anonymous Channel*

We can again re-use some results from the main text because equilibrium prices do not depend on fixed fees. In particular, Lemma 2 continues to hold, so the symmetric equilibrium on the anonymous channel features pricing at marginal cost, $p^a = \phi^a$. Hence, for $\phi^a > v - t/2$, buying via the anonymous channel yields negative utility, and everything is as if only the revealing channel is available, including the platform's optimal fee and profit (see previous subsection). For $\phi^a \leq v - t/2$, all consumers

[21] Not surprisingly, the firms are worse off if the platform can use fixed fees since, for $\alpha = 0$, the platform then extracts their entire surplus, which it cannot do here.

obtain non-negative utility from buying through the anonymous channel, so the market is always covered. As shown in the main text, in a symmetric equilibrium with $p_0^r = p_1^r = p^r$, we have

$$\text{(B.8)} \qquad p^r = \begin{cases} \frac{t}{4} + \frac{\phi^a + \phi^r}{2} & \text{for } \phi^r \geq \phi^a - \frac{t}{2}, \\ \phi^a & \text{for } \phi^a - t \leq \phi^r < \phi^a - \frac{t}{2}, \\ t + \phi^r & \text{for } \phi^r < \phi^a - t. \end{cases}$$

Consumers with $x < \tilde{x}_0$ and $x > \tilde{x}_1$ buy via the revealing channel while the remaining consumers buy via the anonymous channel, where $\tilde{x}_0 = 1 - \tilde{x}_1 = q^r$ given by

$$\text{(B.9)} \qquad q^r = \begin{cases} \frac{1}{2} & \text{for } \phi^r \leq \phi^a - \frac{t}{2}, \\ \frac{1}{4} + \frac{\phi^a - \phi^r}{2t} & \text{for } \phi^a - \frac{t}{2} \leq \phi^r < \phi^a + \frac{t}{2}. \end{cases}$$

The platform's profit is

$$\text{(B.10)} \qquad \pi^P = 2q^r \phi^r + (1 - 2q^r)\phi^a.$$

The following proposition derives the platform's optimal choice of fees.

Proposition 7. The transaction fees on the revealing and anonymous channel that maximise the platform's profit are $\phi^r = v - t/4$ and $\phi^a = v - t/2$. The platform earns $\pi^P = v - 7t/16$.

Proof. Suppose $\phi^a \leq v - t/2$. Using (B.9) to replace q^r in (B.10), we obtain

$$\text{(B.11)} \quad \pi^P = \begin{cases} \phi^r & \text{for } \phi^r \leq \phi^a - t/2 \\ \frac{1}{t}\left(\frac{t}{2} - (\phi^r - \phi^a)\right)(\phi^r - \phi^a) + \phi^a & \text{for } \phi^a - t/2 \leq \phi^r < \phi^a + t/2. \end{cases}$$

We first examine how the platform chooses ϕ^r for a given ϕ^a, and then derive the optimal choice of ϕ^a (taking into account how this affects ϕ^r). The expression in the second line of (B.11) is maximised at $\phi^r = \phi^a + t/4$, which is in the relevant interval since $\phi^a - t/2 \leq \phi^a + t/4 < \phi^a + t/2$. Evaluating the platform's profit at $\phi^r = \phi^a + t/4$ yields $\pi^P = \phi^a + t/16$, which is greater than the maximum value that the platform's profit can attain on the first line, $\phi^a - t/2$.

We conclude that the platform optimally sets $\phi^r = \phi^a + t/4$, and hence that $\pi^P = \phi^a + t/16$ is increasing in ϕ^a. Thus, the platform sets ϕ^a at its maximum value compatible with the anonymous channel being active, $\phi^a = v - t/2$. This implies $\phi^r = v - t/4$ and $\pi^P = v - 7t/16$.

Finally, we show that the platform prefers the above combination of fees to one where $\phi^a > v - t/2$, so that the anonymous channel is inactive, in which case we know from the previous subsection that the platform earns

$$\text{(B.12)} \qquad \pi^P = \begin{cases} \frac{v^2}{4t} & \text{for } v \leq 2t, \\ v - t & \text{for } v > 2t. \end{cases}$$

We have $v - 7t/16 > v - t$, so what remains to be shown is that $v - 7t/16 \geq v^2/4t$ for $v \leq 2t$. This is equivalent to $v \in [t/2, 7t/2]$, and is thus always satisfied when the anonymous channel is viable (Assumption 1) and $v \leq 2t$. ■

Proposition 7 shows that the platform again fully extracts the expected surplus of consumers buying via the anonymous channel by setting $\phi^a = v - t/2$. However, unlike in the case with fixed fees analysed in the main text, the platform no longer sets the same fee on both channels. Instead, it now sets a higher fee on the revealing channel, $\phi^r = \phi^a + t/4$, pushing revealing-channel prices above those that prevail in the presence of fixed fees, and thereby diverting consumers from the revealing to the anonymous channel. The equilibrium price on the revealing channel is $p^r = v - t/8$ (compared to $v - t/4$ with fixed fees), implying $q^r = 1/8$. Thus, whereas consumers split half and half between the revealing and anonymous channels when the platform can use fixed fees, now three-quarters of consumers buy via the anonymous channel. Firms' equilibrium profits are $\pi = t/64$.

By a revealed-preference argument, Proposition 7 also implies that the platform finds it profitable to introduce the anonymous channel. The platform could implement the situation with only a revealing channel by setting $\phi^a > v - t/2$, but as shown in the proof, it prefers to set $\phi^a = v - t/2$ and thus to have both channels active.

To compute welfare, notice that $\pi^P + 2\pi = 2q^r p^r + (1 - 2q^r)p^a$ and $CS = (v - p^r)q^r$. We thus have $W = (v + p^r)q^r + (1 - 2q^r)p^a$. Using the expressions derived above, equilibrium consumer surplus and welfare are

$$CS = \frac{t}{64}; \qquad W = v - \frac{25}{64}t. \tag{B.13}$$

B(iii). *Comparison*

Profits. As discussed above, the platform benefits from introducing the anonymous channel. By contrast, firms earn less than what they earn when only the revealing channel is available: for $v > 2t$, clearly, $t/64 < t/4$, while for $v \leq 2t$, we have $t/64 \leq v^2/16t \Leftrightarrow v \geq t/2$, which is always satisfied by Assumption 1.

Consumer surplus and welfare. Inspection of equations (B.7) and (B.13) reveals that the comparison of consumer surplus is exactly the same as for firms' profits. Thus, the introduction of the anonymous channel always leaves consumers worse off.

The next proposition provides a welfare comparison.

Proposition 8. Compared to the case where only the revealing channel is available on the platform, the presence of both a revealing and an anonymous channel increases welfare when $v \in [t/2, 25t/14]$ and decreases it otherwise.

Proof. Comparing welfare in equations (B.7) and (B.13), we observe immediately that, for $v > 2t$, introducing the anonymous channel lowers welfare since $25/64 > 1/4$. For $v \leq 2t$, we have

$$v - \frac{25}{64}t \geq \frac{7v^2}{16t} \quad \Leftrightarrow \quad 7v^2 - 16vt + \frac{25t^2}{4} \leq 0.$$

The roots of this quadratic equation are $v = t/2$ and $v = 25t/14$. ■

Proposition 8 shows that the results we obtained in the main text, for the case with fixed fees, are qualitatively robust. The anonymous channel is welfare-enhancing when transport costs are high but welfare-reducing when they are low. However, the range of values for which it is welfare enhancing is now larger. This is because the market-expansion effect becomes more important in the absence of fixed fees, since double marginalisation means prices with only a revealing channel are higher so more consumers are excluded.

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