Choosing your battles: endogenous multihoming and platform competition*

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Abstract

We study how digital platforms can choose competitive strategies to influence the number of multihoming consumers. Platforms compete for consumers and advertisers. A platform earns a premium from advertising to singlehomers, as it is a gatekeeper to these consumers. Competitive strategies leading to intense competition on the consumer side reduce profits on that side, but also increase consumer singlehoming and hence market power over advertisers. The size of the singlehoming premium determines where this competitive strategy 'seesaw' will end up. We apply this insight to four strategic choices that may increase singlehoming: reducing product differentiation, portfolio diversification through conglomerate mergers, the choice of compatibility and tying.

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1 Introduction

Big techs started out as very distinct firms. Google used to be a simple search engine. Amazon started as an online book seller, Facebook as a social network, and Apple as a computer manufacturer. But increasingly these firms are developing full digital ecosystems that compete head-on for consumers, as also noted in a recent leader in the Economist.[1] Almost all now offer competing cloud computing services, home assistants, and media distribution platforms. Amazon is considered a major threat to Google's targeted ad services, using its detailed consumer data to help others find their audiences.[2] Facebook recently launched "Facebook Shops" that will use its social network data to direct consumers to online stores, challenging for example Amazon and Ebay.[3] Google's Youtube explores selling products through its videos.[4]

From a competition perspective it is puzzling why these firms choose to compete head-on for consumers, rather than just enjoying a monopoly within their original niche. In this paper, we explore this question. We argue that platforms can choose on which side of the market to compete. Competing head-on for consumers may reduce prices on that side of the market. But offering consumers a one-stop shop also increases market power vis-a-vis e.g. advertisers, [5] since this turns the platform into a gatekeeper towards reaching those consumers. Platforms can thus choose their battles, and choose where to compete fiercely in order to gain market power on the other side of the market. We study a number of applications: product positioning, mergers, compatibility and tying. In all

[1] As the Economist describes,"First, the companies are increasingly selling the same products or services. Second, they are providing similar products and services on the back of different business models, for example giving away things that a rival charges for (or vice versa, charging for a service that a competitor offers in exchange for user data sold to advertisers). Third, they are eyeing the same nascent markets, such as artificial intelligence (ai) or self-driving cars." (from: The new rules of competition in the technology industry, The Economist, Feb 27th 2021).

[2] see e.g. "Amazon Knows What You Buy. And It's Building a Big Ad Business From It." by Karen Weise in the New York Times, Jan. 20 2019.

[3] "Facebook takes on Amazon with online shopping venture", Financial Times, May 2020

[4] "YouTube explores selling products to take on Amazon", competitionpolicyinternational.com, Oct 2020.

[5] More generally, we are thinking about advertising slots, product referrals, targeting data, etc. We will refer to this as advertising, with the implicit understanding that we have in mind broader applications than only showing an ad on one's website.

those applications, we show that our approach generates novel insights.

Our main contribution can be understood as follows. Many big-tech firms act as attention brokers (Wu, 2019): they stand to gain from consumers' attention, as this allows them to sell advertising slots or targeting data (e.g. Facebook or Google), or profit from shopping recommendations (e.g. Amazon). Consumer attention becomes more valuable if consumers singlehome on that platform.[6] By competing head-on on the consumer market, platforms can induce consumers to singlehome, rather than to spend time on many different platforms. This may increase competition for these consumers – and reduce prices on that side of the market – but it also gives the platform more market power on the other side of the market. When consumers are singlehoming on a platform, firms interested in reaching the eyeballs of those consumers have no choice but to go through that platform. The platform then acts as a gatekeeper, so it can charge monopoly access fees from advertisers (Armstrong, 2006; Armstrong and Wright, 2007). Multihoming consumers command lower advertising fees, in line with the lower incremental value of a second impression for advertisers of the same advertisement (Anderson et al., 2017).

We thus argue that platforms can benefit from engaging in strategies that lead to head-on competition for consumers. To that end, we study a model of platforms in which consumers have the possibility of multihoming. Most papers in this literature assume that the number of multihoming consumers is exogenously given (Ambrus et al., 2016; Anderson et al., 2017). Following Gentzkow (2007), we allow consumers to endogenously decide whether to single- or multihome. This is crucial for our argument. By their choice of competitive strategy, platforms affect consumers' choice whether to single- or multihome, which in turn affects the platforms' profits on the advertising market.

Our argument is thus fundamentally different from the well-known point that a platform may charge a low price on one side of the market in order to get the other side on board

[6]Suppose a consumer spends all her time on Facebook, and never uses any other platform. Facebook then has tremendous market power over the eyeballs of that particular consumer. An advertiser that wants to reach her has no other choice than to do so through Facebook. Similarly, in the case of Amazon, shops will be more inclined to sell there if that is the most likely way to reach consumers, or if Amazon can tell them something about those consumers that other platforms cannot.

(see e.g. Rochet and Tirole, 2003). In our model, competing head-on on the consumer side of the market implies having more market power on the advertising side. Hence our argument is about choosing strategies to influence consumers' homing patterns, in order to create market power on the other side of the market, rather than exploiting cross-platform network externalities.

In our general framework, two firms compete in prices in a Perloff-Salop type model. They face a non-negative price constraint (as in e.g. Choi and Jeon, 2021). Patterns of substitutability may differ. At one extreme, products may be completely independent, so the choice to buy one product is independent of whether that consumer buys the other product. At the other extreme, products could be perfect substitutes, so consuming multiple products has no advantages to a consumer whatsoever over and above consuming just one. Take newspapers for example; a consumer may be perfectly happy to buy a sports paper and a general interest newspaper, but is highly unlikely to consume two sports papers as these will largely carry the same news. We allow firms to make strategic choices that affect their product portfolios' positioning, and hence the intensity of competition with their rivals. Head-on competition (say, both firms producing a sports paper) may reduce each platform's total consumer base, but also leads to less sharing of consumers with rivals. Every consumer that single- rather than multihomes at a platform will lead to higher advertising revenues. We will refer to this as the singlehoming rent. These higher advertising revenues may outweigh the loss of revenues from fiercer competition on the consumer-side of the market.

As noted, we discuss four applications of our framework. First, for a duopoly of single-product firms, we find the following. When the singlehoming advertising rent is large, firms are more likely to choose to provide close substitutes, rather than evading competition by creating products that are more strongly differentiated (as according to the principle of maximum differentiation as in e.g. d'Aspremont et al., 1979). If products are more homogeneous, competition is more intense, lowering demand for each firm. However, the resulting reduction in the share of consumers that buy both products increases the number of singlehoming rents earned on the advertising side. When singlehoming rents are large, they more than compensate loss in terms of lower consumer prices.

Second, we study multi-product duopolies. In an initial setting with four firms and two types of products, we allow two mergers; two firms can choose to either merge with their close competitor, or with a firm selling the unrelated product. We find the following. With singlehoming rents sufficiently low, firms prefer mergers-to-monopoly on one product type. However, when singlehoming rents are sufficiently high, they would rather do a conglomerate merger, merging with the supplier of an independent product type, despite the fact that this implies head-on competition with a competing conglomerate that will also form. Again, there is a trade-off between earning more on the consumer side when merging to a single-product-type monopoly, or earning more on the advertiser side when merging to a conglomerate, as that would induce a larger fraction of consumers to singlehome.

Third, we look at the choice of compatibility. In a two-firm duopoly each firm produces its own versions of two complementary products. They can choose to make all products compatible, allowing consumers to mix-and-match, or to make them incompatible, thereby forcing consumers to buy two complementary products from the same firm. With singlehoming rents relatively low, firms prefer compatibility: incompatibility would lead to more intense conmpetition and hence lower consumer prices (see (Matutes and Regibeau, 1992)).[7] Incompatibility does lead to singlehoming, however, so when singlehoming rents are sufficiently high, firms prefer to sell incompatible products instead.

Fourth, we study tying. A monopolist producing two complementary products (say, an operating system and an app) faces entry from a firm selling one of these products (a rival app). We study the monopolist's tying strategy, building on Choi and Jeon (2021).[8] We show that due to singlehoming rents, total industry profits can be higher under tying than if the monopolist allows more efficient competing apps to run on its system. Even when allowing for side payments, tying remains the optimal strategy.[9] We thus provide a novel

[7]Zhou (2017) finds that this conclusion can be invalidated if more than two firms compete.

[8]See also Amelio and Jullien (2012) for an early analysis of tying in the context of a zero-pricing constraint.

[9]In this respect, the mechanism we describe may be closer to that familiar from theories of vertical exclusion, as e.g. Hart and Tirole (1990) or Bernheim and Whinston (1998), than the more traditional predation related mechanisms (Carlton and Waldman, 2002; Tirole, 2005).

theory of harm, based on the difference between single- and multihoming rents, for cases such as the EC's Google Android case.

Our work builds on the literature on platforms, pioneered in e.g. Caillaud and Jullien (2003); Rochet and Tirole (2003); Armstrong (2006). Some recent work studies single- versus multihoming in media markets. Ambrus et al. (2016) and Athey et al. (2018) explore the effects of multihoming on advertising intensity. Anderson et al. (2017) point out how singlehoming premiums can be understood through incremental pricing, while Anderson et al. (2019) explore equilibrium entry in a consumer multihoming setting in a Vickrey-Salop circle model. Our contribution to this literature is to endogenize consumer multihoming by allowing platforms to make strategic decisions that affect consumer homing choices in the subsequent pricing subgame. Choi (2010) is an early paper that considers implications of multihoming from tying decisions of competing platforms. In his paper, consumers' platform choice is determined by content providers. We instead focus on strategic choices made by platforms themselves, where consumers get no direct utility from the other side of the market, a set-up more readily applicable to tech platforms.

Many early papers focus on effects on fee structure, identifying "seesaws" in platform pricing structure (Rochet and Tirole, 2006), where a platform may reduce price on one side of the market to be able to attract more higher-margin consumers on the other side. Belleflamme and Peitz (2019) and Liu et al. (2020) explore which side of the platform benefits when the extent of multihoming changes exogenously on either side. Our paper argues that platforms may also face a seesaw in the competitive strategies that precede the pricing stage. If platforms compete head-on for consumers, these consumers are more likely to singlehome, which softens the platforms' competition for advertisers as platforms gain a monopoly on access to their consumers.[10] Softening competition for consumers induces consumers to multihome, which intensifies competition for advertisers.

Other related literature includes the following. In Klemperer (1992) consumers face shopping costs, and multi-product firms choose minimum differentiation and to compete

[10] Anderson and Peitz (2020) refer to a "seesaw" involving the extent to which interests of advertisers and consumers are aligned.

head-on to avoid that consumers also visit their competitor. In Gabszewicz et al. (2004), free-to-air media firms compete in advertising time to attract ad-avoiding consumers. With minimum differentiation, cutthroat competition forces the amount of advertising to zero, hence media firms cannot make any money from ads on their platform. In Gal-Or and Dukes (2003) however, advertising serves to inform consumers, so less advertising leads to more market power for advertisers, hence media firms can charge higher advertising prices. This gives them an incentive for minimum differentiation. Peitz and Valletti (2008) compare pay-tv versus advertised financed free-to-air television, and finds that in the latter, content differentiation decreases with consumers' ad nuisance. Our contribution to this literature is the focus on singlehoming rents from advertisers that may result from more intense competition on the platform's consumer side.

We do not address the total welfare effects of the firms' strategies we study. This would require, among other things, more detail on the advertising side, as e.g. Prat and Valletti (2019) who consider implications for competition between advertisers in their sales to ultimate consumers.

The remainder of this paper is structured as follows. In Section 2, we present our general framework. The case of product positioning is analyzed in Section 3, while Section 4 studies mergers. Compatibility is discussed in Section 5, and we consider tying in Section 6. Section 7 concludes.

2 The General Framework

The firms make money not only from selling their products to consumers, but also from gaining access to these consumers. For example, the firms may be able to show advertisements to the users of their product. Also, the firms may use the data from their consumers for other purposes, for example selling these to potential advertisers or using them to improve their recommendations systems. Either way, having access to consumers' eyeballs is valuable for a firm. For ease of exposition, in the remainder of the paper we will simply refer to this as advertising.

Consumers We model consumers in Perloff-Salop (1985) fashion. There is a unit mass of consumers. They differ in their valuation for each product. Consider one representative consumer. Her stand-alone utility from consuming product i is denoted by v_i, and is a random draw from some distribution F_i on $[0, 1]$. Of course, the upper bound of this distribution is just a normalization. For simplicity, we will assume that valuations for all products are independent draws from the same distribution, so $v_i \sim F$. We assume F is smooth, and density f is strictly positive on $[0, 1]$.

Consumers pay price P_i for product i. We assume that firms can only charge non-negative prices, as abuse by consumers of negative prices would be hard to police. Hence, $P_i \geq 0$. Consumers have unit demand for each individual product. However, a consumer may consume more than one product. If she does, her total utility may not simply be the sum of the individual utilities of all products she buys: it will also be affected by how the products are related to each other. When reading two newspapers for example, there will be some overlap in the news that they cover. Also, when subscribing to a second video streaming service, most people will not double their time spent watching TV – nor their enjoyment in doing so. In other words, the total utility a consumer derives from consuming i and j will be lower than the sum of the willingnesses-to-pay for these two platforms when consumed in isolation. Following Gentzkow (2007) we simply assume that total utility will shift downwards by some constant Γ_{ij} when i and j are both consumed.

More precisely, let I_i be a dummy that denotes whether this consumer buys product i. Thus $I_i = 1$ if she buys i, and $I_i = 0$ if not. We also construct such a dummy for all other products. We then assume that total utility is given by

$$u = \sum_{i=1}^{n} (v_i - P_i) I_i - \sum_{i \neq j}^{n} \Gamma_{ij} I_i I_j.$$

In this equality, $\Gamma_{ij} \in [0, 1]$ represents the degree of substitutability between products i and j. Suppose that $\Gamma_{ij} = 0$. Then the total utility of consuming i and j simply equals the sum of their individual utilities. Hence the two products are completely independent of each other: consuming one does not compromise the utility obtained from consuming the other. However, if $\Gamma_{ij} = 1$, then consuming both of these products cannot possibly add value to the utility of consuming just one of them.[11] In that sense, i and j are now perfect substitutes.[12] This formulation is a generalization of Gentzkow (2007), who assumes that each two products have the same Γ.

Advertisers A continuum of advertisers tries to reach consumers. If a consumer uses the product(s) of only one particular firm, then that firm has a monopoly over access to that consumer vis-a-vis advertisers. If the consumer buys products from bothfirms, then those firms have to compete for advertisers that want to reach that consumer. Competition for advertisers can be modelled in numerous ways. We simply assume that a firm can earn an amount π_m in advertisement revenues from each of its consumers that multihomes, i.e. that also buys products from other firms. A consumer that singlehomes and only buys a single product from one firm, generates advertising revenues π_s for that firm, with $\pi_s \geq \pi_m$, reflecting that there is a premium to having a monopoly on access to a consumer. A consumer that singlehomes but buys two different products from a single firm, generates advertising revenues π_t for that firm, with $\pi_t \geq \pi_s$.

This reduced form captures many advertising models. For example, if advertisers only value a single exposure to any consumer and firms compete for advertisers in Bertrand fashion, we would simply have $\pi_m = 0$, since the firms would compete away all access rents. Also, $\pi_t = \pi_s$, where π_s would reflect advertisers' total willingness to pay. If also a second exposure has value, we would have $\pi_m > 0$ as well, with each firm being able to only capture the incremental rents of the second exposure, as in Anderson et al. (2017). More specifically, suppose that a_1 reflects the willingness-to-pay of advertisers for a first exposure[13], while a_2 reflects that for a second exposure. Suppose moreover that a platform can make take-it-or-leave it offers to advertisers that are singlehoming, while there is Bertrand competition for ads to multihoming consumers. In that case, we would

[11] Consuming only i, for example, would yield $u = v_i - P_i$, while consuming both i and j would yield $u = v_i - P_i + v_j - P_j - \Gamma_{ij}$. With $\Gamma_{ij} = 1$, $v_j \leq 1$ and non-negative prices, this is always weakly lower.

[12] At least, they are so for the consumers on aggregate. Of course, each individual consumer does have different valuations for the two products.

[13] Note therefore that we assume that advertising on one product yields one and only one impression.

have $\pi_s = a_1$ and $\pi_t = a_1 + a_2$, while π_m would be competed down to the value of the second impression, so $\pi_m = a_2$.

For simplicity, we assume that there is no disutility to consumers from watching advertisements: allowing for that would not affect our qualitative results.

Firms We assume that the marginal costs of production for product i are constant and equal to c. Every sale that it makes will then imply a cost of c, but also an advertising revenue of (at least) π_m. For ease of exposition, in the remainder of the paper we will use the net marginal cost, defined by $C = c - \pi_m$, of making a sale.[14] Note that we may very well have $C < 0$, if (multihoming) advertising benefits outweigh production costs. Hence, using this convention, if a firm sells a product to a multihoming consumer, it has net marginal costs C and revenues P_i. If the firm sells a single product to a singlehoming consumer, it has net marginal costs C and revenues $P_i + R$,with $R \equiv \pi_s - \pi_m$. In other words, R is the monopoly premium that a firm can earn from having unique access to a consumer's eyeballs, and captures the incremental value as highlighted in Anderson et al. (2017). We will refer to R as the singlehoming rent, and it is this quantity that will play a crucial role in the analysis.

Firms play a two-stage game. First, they make strategic decisions regarding their product portfolio. Second, they compete in prices. In the pricing game, firms choose prices P_i for the products in their portfolio to maximize their profits. These profits consists of the margin $P_i - C$ on each product sold, plus the premium R for each consumer that singlehomes at that firm.

We are particularly interested in the competitive strategies firms choose in stage 1. We look at three examples. In our first application, firms make choices regarding product substitutability. In the second, firms will engage in a merger, and have to choose whether to merge with a firm that sells a perfect substitute or one that provides an independent product. The third application has firms making compatibility choices. In each of our

[14] We also use the simplification that $\pi_t = \pi_s + \pi_m$, so that indeed net marginal costs are the same for each product.

applications, firms make choices that affect their product portfolios. Given the resulting product portfolio as reflected in the ownership structure and substitutability matrix Γ, the pricing subgame ensues.

3 Application 1: choice of platform content

As a first application, we consider competition between two single-product firms that first position their product by choosing the content of their platform, and then compete in prices. Product positioning is captured by our measure of product substitutability Γ_{12}. As this application only has two products, we simply refer to this as Γ in the remainder of this application. For example, consider two news sites that have to decide what type of news to run. They may each choose to run general news, in which case Γ would be close to 1. Alternatively, one may choose to run general news while the other focuses on sports. In that case, Γ would be close to zero.

The timing is as follows:

1. Firm 1 enters the market and chooses its content.

2. Firm 2 enters and chooses its content relative to firm 1, as measured by Γ.

3. After having observed Γ, firms simultaneously and noncooperatively set non-negative prices P_1 and P_2.

4. Consumers make their purchasing decisions and ad revenues are realized.

We first study the subgames with $\Gamma = 0$ (independent products) and $\Gamma = 1$ (perfect substitutes). We then allow for intermediate choices of Γ. We focus on symmetric equilibria in the subsequent pricing games, so firms 1 and 2 make identical profits in equilibrium. The equilibrium positioning choice will then simply be the choice that maximizes total profits, making the assumption that it is firm 2 that chooses Γ inconsequential.[15]

[15] Alternatively, we could consider simultaneous content choices, resulting in a coordination game, with the same outcome for the profit maximizing equilibrium, but leaving the question how firms would coordinate on this equilibrium.

3.1 Perfect substitutes: $\Gamma = 1$

With $\Gamma = 1$ platforms are perfect substitutes and it makes no sense for consumers to multihome: doing so would always lower their net utility. A consumer will use platform 1 whenever

$$v_1 - P_1 \geq v_2 - P_2$$
$$v_1 - P_1 \geq 0$$

This is area 1 in Figure 1 – which we have drawn for the case that $P_1 > P_2$. In that Figure, consumers in area 2 buy from firm 2, while consumers in area $\emptyset$ refrain from consumption.

Consumer singlehoming implies that effectively platforms are monopolists on the market for advertisements: as there is no multihoming they simply earn the singlehoming premium R in ad revenues for each consumer that they attract. To derive equilibrium prices, assume without loss of generality that $P_1 \geq P_2$. From Figure 1, total profits of firm 1 are then given by

$$\pi_1 = (P_1 - C + R) \int_{P_1}^{1} F(v_1 + P_2 - P_1) dF(v_1) \tag{1}$$

Taking first-order conditions with respect to P_1 and imposing symmetry yields

$$P^* - C + R = \frac{1 - F^2(P^*)}{2f(P^*)F(P^*) + 2\int_{P^*}^{1} f(v)dF(v)},$$

where the left-hand side equals the average mark-up. If this yields negative prices, we have a corner solution with $P^* = 0$.

In equilibrium, each firm's profits are

$$\pi^* = (P^* - C + R)\frac{1}{2}\left(1 - F^2(P^*)\right).$$

This is intuitive: firms simply share the part of the market that is covered (i.e. all consumers except for the "zerohoming" consumers, area $\emptyset$ in Figure 1, that has size $F^2(P^*)$).

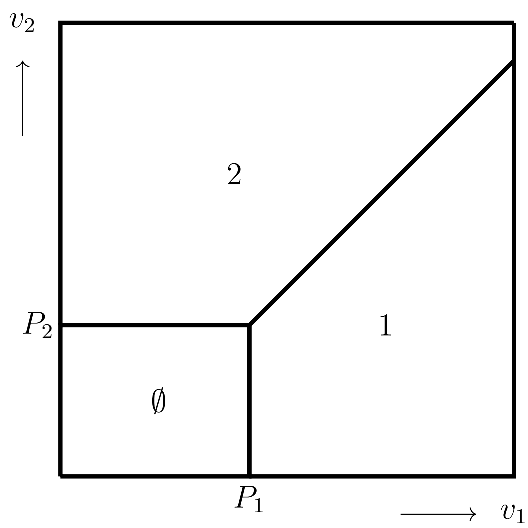

Figure 1: $\Gamma = 1$, perfect substitutes

Example For the uniform distribution, $F(v) = v$, and with $C = 0$, the first-order conditions can be solved to

$$P^* = \sqrt{2}\sqrt{1-R} - 1.$$

Note that this solution is only feasible with $R \leq 1/2$: for higher values of R, optimal prices would be negative. As we do not allow for that, we get a corner solution at $P^* = 0$. Equilibrium profits for the case $R \leq 1/2$ now equal

$$\pi^* = (1-R)\left(3 - R - 2\sqrt{2}\sqrt{1-R}\right).$$

It is easy to see that this is increasing in R. With $R > 1/2$, equilibrium prices are zero, so profits become

$$\pi^* = \frac{1}{2}R.$$

3.2 Independent products: $\Gamma = 0$

Next, consider independent products: $\Gamma = 0$. In this scenario, platforms are effectively monopolists on the consumer side of the market; their demand does not depend on the

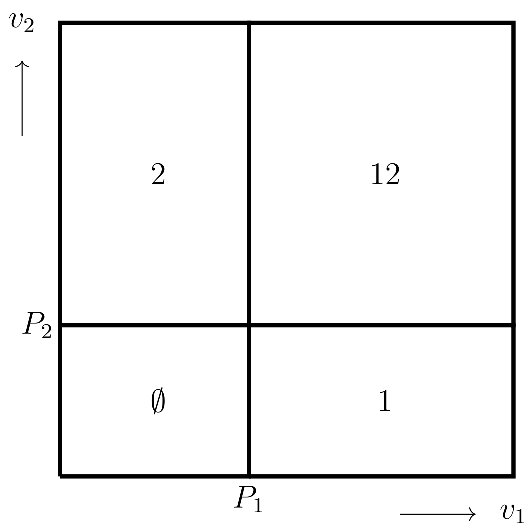

Figure 2: $\Gamma = 0$, independent products

price charged by the other firm. Of course, they do now compete on the ad market for advertisements to consumers that multihome. Consumers with $v_1 \geq P_1$ will use platform 1, those with $v_2 \geq P_2$ will use platform 2, those for whom both conditions are satisfied will multihome (see Figure 2).

Profits of platform 1 are given by

$$\pi_1 = (P_1 - C)(1 - F(P_1))(1 - F(P_2)) + (P_1 - C + R) F(P_2)(1 - F(P_1)),$$

where the first term represents the multihomers (area 12 in Figure 2), while the second represents the singlehomers (area 1 in Figure 2). The firm only earns the advertising monopoly premium R for the latter group.

First-order conditions for the symmetric equilibrium reduce to

$$P^* - C + RF(P^*) = \frac{1 - F(P^*)}{f(P^*)}.$$

The left-hand side is the average mark-up, which includes the singlehoming premium R only on the fraction $F(P^*)$ of consumers that do not buy the rival's product. The right-hand side is the hazard rate for the distribution of v. As long as net marginal costs C are non-negative (in other words, marginal costs c exceed the advertising revenue made on multihoming consumers π_m), prices will never go to zero: at $P^* = 0$, all consumers would multihome and platforms would make non-positive profits. Equilibrium profits are

$$\pi^* = (P^* - C)(1 - F(P^*)) + RF(P^*)(1 - F(P^*)).$$

Example Continuing the example with a uniform distribution of preferences and $C = 0$, we find

$$P^* = \frac{1}{2+R}.$$

As pointed out, although prices decrease in R (platforms are more eager to attract consumers as their ad revenues from a consumers increase) prices never go down to zero. Total profits now equal

$$\pi_1 = \left(\frac{1+R}{2+R}\right)^2,$$

which is also increasing in R.

3.3 Intermediate values of Γ

With $0 < \Gamma < 1$, we may have an equilibrium as depicted in Figure 3; this requires that in equilibrium $P^* + \Gamma < 1$, so consumers that have a sufficiently high valuation for both products will multihome.

In such an equilibrium, from Figure 3, the number of consumers that singlehomes at platform 1 is given by

$$Q_1 = \int_{P_1}^{P_1+\Gamma} F(v_1 + P_2 - P_1)dF(v_1) + (1 - F(P_1 + \Gamma))\, F(P_2 + \Gamma), \tag{2}$$

while the number of multihomers is

$$Q_{12} = (1 - F(P_1 + \Gamma))(1 - F(P_2 + \Gamma)).$$

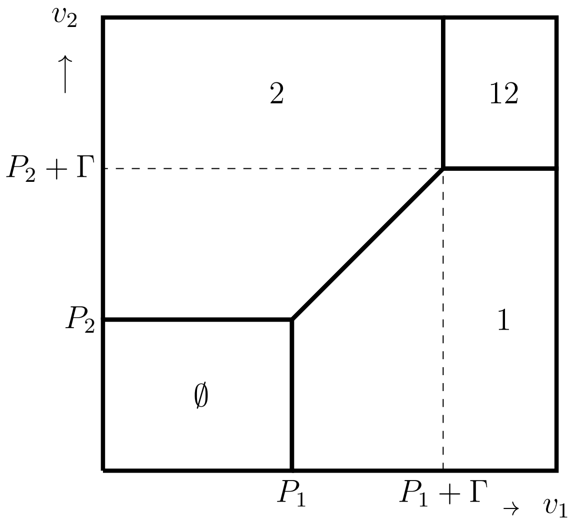

Figure 3: Γ intermediate

Total profits for firm 1 are

$$\pi_1 = (P_1 - C + R)Q_1 + (P_1 - C)Q_{12}.$$

Taking the first-order condition for P_1 and imposing symmetry then yields:

$$\int_{P^*}^{P^*+\Gamma} F(v)dF(v) + (1 - F(P^* + \Gamma)) = (P^* - C + R)\left[f(P^*)F(P^*) + \int_{P^*}^{P^*+\Gamma} f(v)dF(v)\right] + (P^* - C)f(P^* + \Gamma)\left(1 - F(P^* + \Gamma)\right).$$

If $P^* = 0$, the square of zerohomers vanishes; firms obtain profits $R-C$ from singlehoming, and $-C$ from multihoming consumers, yielding profits

$$\pi_1(P = 0) = (R - C)\frac{1}{2}\left(1 - (1 - F(\Gamma))^2\right) - C\left(1 - F(\Gamma)\right)^2.$$

Example Again using our uniform example with $C = 0$, the first-order condition collapses to

$$P^* = \frac{1 - \Gamma(1 + R) + \frac{1}{2}\Gamma^2}{2 + R - \Gamma},$$

and profits follow straightforwardly.

3.4 The product positioning stage

We now look at the first stage of the game, where platforms choose their content. We study how the importance of singlehoming advertising rents R affects the positioning of platforms relative to each other. While the details of the transition in equilibrium from $\Gamma = 0$ to $\Gamma = 1$ will vary according to the characteristics of the distribution $F(v)$, the qualitative shift is general (proof in appendix):

Proposition 1 *With R sufficiently small, platforms maximize profits by differentiating their content as much as possible:* $\Gamma = 0$. *For R sufficiently large, profits are maximized with perfect substitutes:* $\Gamma = 1$.

With $R = 0$ we have standard profit maximization: firms seek a high margin on a high volume of consumers. They can achieve this by differentiating their product as much as possible from their competitor's. By doing so they establish a monopoly which allows them to charge their monopoly prices without having to worry about their rivals' actions. Consumers with a high willingness to pay for both products end up buying both.

When $R > 0$, however, a platform cannot extract singlehoming advertising rents from consumers that also buy the competitor's product. The higher R, the more platforms start focusing on obtaining a high volume of consumers *that are not also served by their rival.* This can be achieved by offering a product that is virtually identical, creating fierce competition for consumers. For large R, the gain in singlehoming advertising rents from offering a perfect substitute, more than offsets the decrease in profits due to fierce competition on the consumer side. The non–negative-pricing constraint is important in this argument: if firms could charge negative prices, higher advertising rents would mostly be competed away by charging ever lower prices to consumers.

Hence, by their choice of Γ, platforms can effectively choose to compete head-on for consumers (by producing perfect substitutes and setting $\Gamma = 1$) or to compete head-on for advertisers (by producing independent products and setting $\Gamma = 0$). If advertising rents from singlehoming are not so important, R is low, and platforms prefer to monopolize the consumer market, while competing vigorously for advertisers. As advertising singlehoming rents become more important however, at some point it becomes more profitable to turn all consumers into singlehomers: by doing so platforms monopolize the advertising market, competing fiercely for consumers instead.

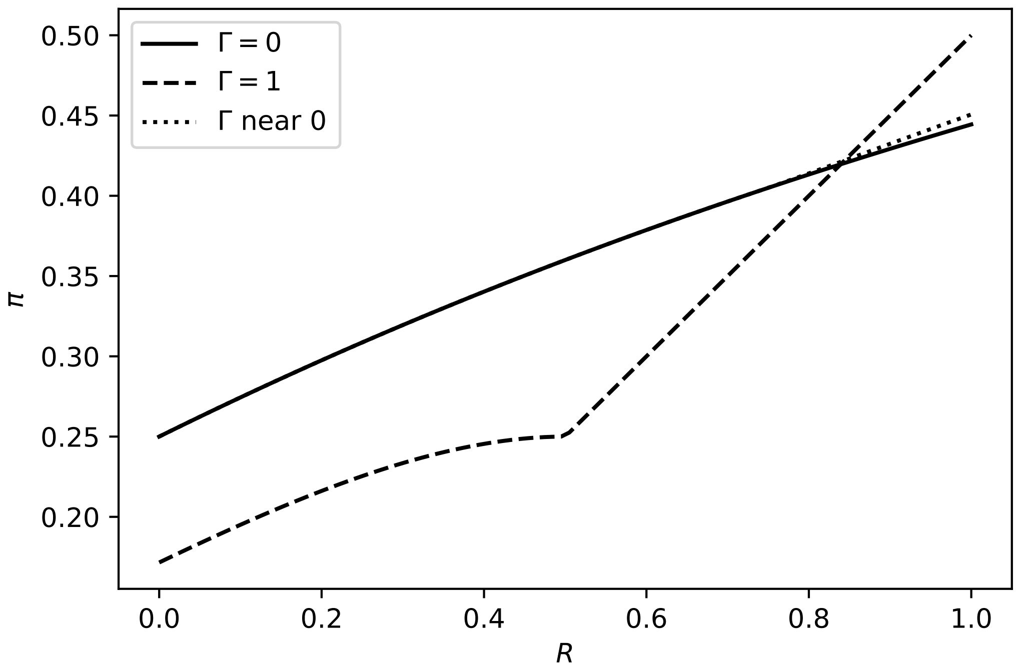

Figure 4: Profits, as a function of R, for $\Gamma = 0, \Gamma = 1$, as well as optimal intermediate Γ

Example In our example with uniform distributions and $C = 0$, we can explicitly solve for the optimal Γ for any R. Figure 4 compares equilibrium profits for the cases $\Gamma = 0$ and $\Gamma = 1$. With $\Gamma = 0$, the kink at $R = 1/2$ is caused by the switch from strictly positive prices to prices that equal zero. Beyond $R = 1/2$ the curve becomes steeper: an increase in R is no longer largely competed away by a decrease in equilibrium prices. From the graph it is clear that platforms prefer to set $\Gamma = 1$ if and only if the advertising market is sufficiently important (so R is sufficiently high). The shift from $\Gamma = 0$ to $\Gamma = 1$ is not completely bang-bang in this example: in a small region, just before the $\Gamma = 1$ profits start dominating the $\Gamma = 0$ profits, it is profit-maximizing to set Γ close to, but not equal to 0.

4 Application 2: multi-product platform mergers

As a second application of our framework we look at competition among multiproduct firms. We explore whether firms want to sell portfolios of rather similar products, or rather prefer to have diversified portfolios. For example, suppose we have two competing gaming platforms, and two competing search engines. Is a merger wave then likely to lead to a single gaming platform and a single search engine,[16] or are we more likely to see two search-and-gaming conglomerates emerge? We cast this strategic question in terms of a model of two subsequent mergers.

Consider four products $1, 2, 3$, and 4 that are initially produced by 4 different firms. Assume that the matrix of substitution parameters $\mathbf{\Gamma}$ is given by

$$\mathbf{\Gamma} = \begin{bmatrix} . & 1 & 0 & 0 \\ 1 & . & 0 & 0 \\ 0 & 0 & . & 1 \\ 0 & 0 & 1 & . \end{bmatrix}. \quad (3)$$

Hence, products 1 and 2 are perfect substitutes for each other, as are 3 and 4. But any $i \in \{1, 2\}$ is independent of any $j \in \{3, 4\}$. 1 and 2 could be two gaming platforms, while 3 and 4 could be two search engines. We again assume that $v_i \sim F(v)$. For ease of exposition and to focus on the fact that we are looking at two different product types, we will label these four products as $A1$, $A2$, $B1$ and $B2$ respectively.

Consider two firms, those currently producing $A1$ and $B1$. In the first stage of the game both firms can engage in a merger with one of the two remaining products $A2$ and $B2$,

[16] Provided of course that antitrust authorities would allow such mergers.

hence forming a duopoly of two-product firms. These two symmetric two-product firms then compete. Hence, the timing is as follows:

1. Firm $A1$ chooses whether to merge with $A2$ or with $B2$.
2. Firm $B1$ merges with the remaining firm.
3. Firms simultaneously and non-cooperatively set prices for the products they sell.
4. Consumers make their purchasing and ad revenues are realized.

Again, firms make money not only from selling to consumers, but also from showing ads or otherwise having access to them. With firms being symmetric, the sequence of mergers is without loss of generality: $A1$ may choose to merge with $A2$, leaving competition among an AA firm and a BB firm. Or $A1$ merges with $B2$, leading to a symmetric duopoly of two AB firms competing against each other. The equilibrium strategy will be choosing the merger that maximizes both firms' profits.

Below, we first study the two subgames. We then show that when R is small, firms choose to merge with their close substitutes. If R is large, however, firms are better off creating diversified product portfolios through their choice of merger.

4.1 Analysis

First consider the merger of substitutes that leads to competition between an AA and a BB firm, each a monopolist in their own product market. With $A1$ and $A2$ being substitutes, consumers will buy at most one of these. In equilibrium, firm AA will set the same price P_A for each of its products and consumers choose the product that gives the highest v_i, if any. As the cumulative distribution of $\max\{v_1, v_2\}$ is given by $F^2(v)$, the firm's profits are given by

$$\pi_{AA} = \left(1 - F^2(P_A)\right)\left(P_A - C + RF^2(P_B)\right),$$

with P_B the price that the other firm charges for products $B1$ and $B2$. Firm AA collects the singlehoming premium R only for its consumers that buy neither $B1$ nor $B2$ (which is a share $F^2(P_B)$).

The analysis is the same as the $\Gamma = 0$ case in the preceding section, with F^2 replacing F. The first-order condition for a symmetric interior equilibrium at price P^* is given by

$$P^* - C + RF^2(P^*) = \frac{1 - F^2(P^*)}{2F(P^*) \cdot f(P^*)}. \tag{4}$$

The left-hand side is the average mark-up, including the singlehoming premium on part of the consumers. This mark-up equals the hazard rate for the distribution of the maximum valuation F^2 on the right-hand side. If C is non-negative, the zero-pricing constraint will never bind.

Now consider a merger of independent products. We then have two firms: firm 1 sells A1 and B1, while firm 2 sells A2 and B2. On the consumer side, for each of the two product types, the analysis is identical to that of $\Gamma = 1$ in the previous section. But the advertising side will be different. There will now be multihoming consumers: those that buy products A and B from different firms. Without loss of generality, suppose $P_{A1} \geq P_{A2}$ and $P_{B1} \geq P_{B2}$. Denote the sales of product αi as $Q_{\alpha i}$, with $\alpha, i \in \{A, B\} \times \{1, 2\}$. Similar to (1), we have

$$Q_{\alpha 1} = \int_{P_{\alpha 1}}^{1} F(v_{\alpha 1} - P_{\alpha 1} + P_{\alpha 2}) dF(v_{\alpha 1}), \tag{5}$$

with a similar expression for $Q_{\alpha 2}$.

We now derive profits of firm 1. Note that this firm earns the singlehoming rent R on three types of consumers. First, there are those that buy $A1$ and do not buy any product B. This is a mass $Q_{A1}\left(1 - Q_{B1} - Q_{B2}\right)$. Second, there are those that buy $B1$ and do not buy any product A. This is a mass $Q_{B1}\left(1 - Q_{A1} - Q_{A2}\right)$. Third, there are those that buy $A1$ and $B1$. This is a mass $Q_{A1}Q_{B1}$. Profits of firm 1 can thus be written

$$\begin{aligned} \pi_1 &= \left(P_{A1} - C\right) Q_{A1} + \left(P_{B1} - C\right) Q_{B1} \\ &\quad + R\left[Q_{A1}\left(1 - Q_{B1} - Q_{B2}\right) + Q_{B1}\left(1 - Q_{A1} - Q_{A2}\right) + Q_{A1}Q_{B1}\right], \end{aligned} \tag{6}$$

We look for a symmetric equilibrium. Suppose firm 1 charges price P_1 for $A1$ and $B1$, while firm 2 charges P_2 for the products that it sells. The markets for both types of products are then symmetric so we can write $Q_{A1} = Q_{B1} \equiv Q_1$ and $Q_{A2} = Q_{B2} \equiv Q_2$ and profits of firm 1 collapse to

$$\pi_1 = 2\left(P_1 - C\right)Q_1 + R\left[2Q_1\left(1 - Q_1 - Q_2\right) + Q_1^2\right]. \tag{7}$$

Taking the FOC with respect to P_1, using (5) and imposing symmetry yields

$$Q^* = \left(P^* - C + R\left(1 - Q^*\right)\right)\left(F(P^*)f\left(P^*\right) + \int_{P^*}^{1} f\left(v\right)dF\left(v\right)\right) - RF(P^*)f\left(P^*\right)Q^*. \tag{8}$$

From Figure 1 it easy to see that in symmetric equilibrium, $Q^* = \frac{1}{2}\left(1 - F^2(P^*)\right)$. Plugging that into (8) then gives an implicit solution for P^*.

Equilibrium profits can now be written

$$\pi_1 = \left(P^* - C\right)\left(1 - F^2(P^*)\right) + R \cdot \left[\left(1 - F^2(P^*)\right)F^2(P^*) + \frac{1}{4}\left(1 - F^2(P^*)\right)^2\right],$$

where the first term reflects the income from consumers, while the R-dependent terms consist of those consumers that only consume $A1$ or only $B1$ (first term in the square brackets), plus those who consume both $A1$ and $B1$ (second term). Finally, $\pi_1 = -C + \frac{R}{4}$ in case the zero-price constraint binds.

Example For the uniform situation with zero net costs, for a merger of substitutes the equilibrium condition (4) simplifies to

$$3P^{*2} + 2RP^{*3} - 1 = 0.$$

For the merger of independent products, we have from (8),

$$2P^* + R(1 + P^{*2} - P^* + P^{*3}) = 1 - P^{*2}.$$

Figure 5 plots the resulting profits. With $R = 0$, we have the standard intuition that a merger with a close (in this case, perfect) substitute is preferable for the firm, as it allows for price coordination to fully monopolize that market. When R is large, however, there are large rents to be gained by instead monopolizing the advertising market as much as possible. This is better achieved by a merger of independent products, thus creating a larger number of 'one-stop shoppers' that cannot be reached by advertisers through the rival platform.

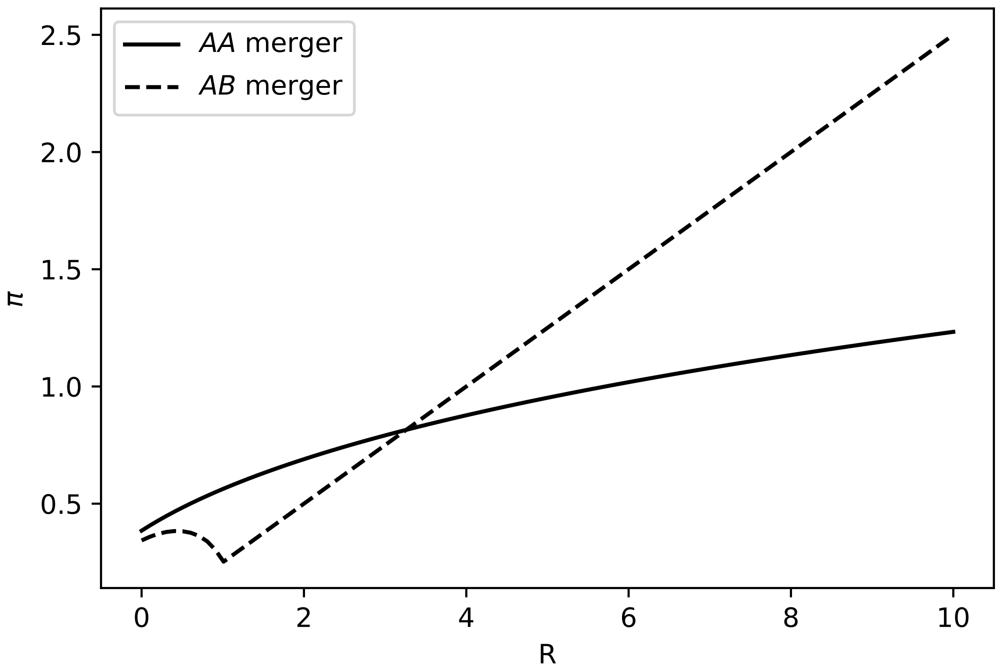

Figure 5: Profits, as a function of R, for mergers with substitutes and with fully differentiated products

This insight extends to the case with general costs C and distribution F:

Proposition 2 *For R small enough, a merger of substitutes maximizes profits. For R sufficiently large, a merger of independent products maximizes profits.*

Proof In Appendix.

There is a strategic see-saw effect that depends on the size of the singlehoming rent R. Firms face a tradeoff between competing on the consumer market and competing on the advertising market. For small R, profits on the consumer market outweigh those on the advertising markets, and firms try to soften competition for consumers. They can do so by establishing monopolies, hence by merging with firms that offer substitute products. For large R, profits on the advertising markets outweigh those on the consumer markets, and firms try to soften competition for advertisers. They can do so by offering unique eyeballs to advertisers and offering a one-stop shop to consumers, hence by merging with firms that offer independent products.

5 Application 3: Standardization or incompatibility

Next, we look at compatibility choices for two competing multi-product firms. Suppose firm 1 offers $A1$ and $B1$, while firm 2 offers $A2$ and $B2$. Again, products of the same type are substitutes (so $\Gamma_{A1A2} = \Gamma_{B1B2} = 1$) while different types of products are independent from each other. Firms can now choose to make their products compatible, by adopting common standards, or to make them incompatible, so that a consumer buying $A1$ can enjoy $B1$, but not $B2$. An example would be two software producers, both selling a web browser and a video app. Under standardization, firm 1's browser would be able to interface well with 2's video-app. Under incompatibility, the web browser and video app would be tightly integrated, making it impractical for consumers to mix products from the two firms.[17]

For simplicity, we assume that the markets for both product types are fully covered (see e.g. Zhou, 2017). One may interpret this as both goods being 'must-have' goods. The choice between incompatibility and standardization boils down to choosing either pure bundling or mix-and-match strategies (Matutes and Regibeau, 1992)

[17]Note that we could also consider this model as one of bundling. By offering bundles, firms could also make sure that consumers that buy from them, also buy both A and B. However, that would require that no consumer would find it worthwhile to buy a bundle from both firms, just to be able to obtain its favorite A and B. In cases where the non-negativity constraints on prices are binding, that condition would clearly be violated.

In terms of our general framework, note that in the context of fully covered markets the choice for incompatibility boils down to having $\Gamma_{A1B2} = \Gamma_{A2B1} = 1$, while the choice for standardization implies $\Gamma_{A1B2} = \Gamma_{A2B1} = 0$. On the advertising side, we keep assumptions as before, with each firm earning an additional monopoly rent R over those consumers that exclusively buy that firm's products.

The timing is now as follows:

1. Firms choose whether to make their products incompatible with their rival's, or to allow consumers to mix and match by opting for standardization.

2. Firms set prices for both products.

3. Consumers make their purchasing decisions.

Note that if one firm chooses to make its products incompatible with their rival's in stage 1, then it de facto forces the other firm to make that same choice.

First consider the case in which the firms choose to make their products incompatible. By construction, all consumers then singlehome. Suppose that firm 1 charges P_1 for each product in its bundle, so its bundle price is $2P_1$. Firm 2 charges P_2 for each product. Denote $v_i^+ \equiv v_{Ai} + v_{Bi}$, and denote the corresponding density of v^+ as F^+. A consumer will buy a bundle from firm 1 whenever $v_1^+ - 2P_1 > v_2^+ - 2P_2$. Assume without loss of generality that $P_1 \geq P_2$. Profits of firm 1 then equal

$$\pi_1^{\text{incomp}} = (2P_1 - 2C + R) \int_{2P_1 - 2P_2}^{2} F^+ \left(v + 2P_2 - 2P_1\right) dF^+(v).$$

Maximizing, imposing symmetry and using the fact that in equilibrium sales per firm have to equal 1/2, we have the following condition for an interior ($P > 0$) symmetric equilibrium[18]:

$$2P^* - 2C + R = \frac{1}{2\int_0^2 f^+(v) dF^+(v)}. \tag{9}$$

[18]This essentially boils down to a two-product computation with full substitutes, $\Gamma = 1$, as in section 3.1

The left-hand side is the average markup per bundle. Symmetric profits are $\pi^{\text{incomp}} = P^* - C + \frac{R}{2}$ (or $R/2 - C$ if prices are zero in equilibrium).

Now consider the case with standardization. Firms then compete separately on each market. Profits from the ad channel connect the two markets: only for those that buy both A and B products from a single firm does that firm receive R. Suppose that firm 1 charges P_1 for $A1$ and $B1$, while firm 2 charges P_2 for the products that it sells. Again, assume without loss of generality that $P_1 \geq P_2$. On each market, firm 1 then sells Q_1 units, with

$$Q_1 = \int_{P_1 - P_2}^{1} F(v + P_2 - P_1) dF(v),$$

Since valuations are independent, profits of firm 1 equal

$$\pi_1^{\text{stand}} = 2(P_1 - C)Q_1 + RQ_1^2,$$

where Q_1^2 reflects the share of consumers that buy both products from firm 1. The first-order conditions for an interior symmetric equilibrium now simplify to

$$2P^* - 2C + R = \frac{1}{\int_0^1 f(v) dF(v)}, \tag{10}$$

and equilibrium profits are $\pi^{\text{stand}} = P^* - C + \frac{R}{4}$.

Example For the uniform situation with zero net costs, first note that

$$f^+(v) = \begin{cases} v & \text{for } v < 1 \\ 2 - v & \text{for } v > 1, \end{cases}$$

hence $\int_0^2 f^+ dF^+(v) = \int_0^2 f^+(v)^2 \, dv = 2/3$, which implies from (9) that the equilibrium markup for the combined goods is $2P^* + R = \frac{3}{4}$, which in turn implies profits of $\pi^{\text{incomp}} = \frac{3}{8}$.

With standardization, we immediately have from (10) that $P^* + \frac{1}{2}R = \frac{1}{2}$, so total profits are $\frac{1}{2} - \frac{1}{4}R$. Hence, with $R = 0$, the firms would prefer standardization, allowing mix-and-match purchases. Incompatibility leads to fiercer competition for consumers to either buy all or nothing at a particular firm. Hence, selling separate, standardized products leads to higher equilibrium prices. For $R > 1/2$ however, firms would prefer to make products incompatible. By doing so all their clients become one-stop shoppers that cannot be reached by advertisers through the rival firm.

This insight extends to the case with general costs C and distribution F:

Proposition 3 *For sufficiently small R, in a two-product duopoly, firms choose to offer standardized products, allowing consumers to mix and match; this maximizes profits. For R sufficiently large, firms choose to make products incompatible, selling them as bundles, so consumers can only combine products A and B from a single firm.*

With $R = 0$ standardization dominates since it intensifies competition. Since the distribution of the average of two i.i.d. variables is more strongly peaked than that of each individual variable, there is a larger density of marginal consumers. For positive R, firms lose advertising income from the mix-and-match consumers. Advertisers can reach those consumers through either firm, and competition for advertisers drives down ad revenues. Instead, with incompatibility, firms monopolize access to consumers, as they provide a one-stop shop. In their choice whether to standardize, firms thus trade off the loss from lower prices against the extra profits from monopolizing advertising to their consumers.

6 Application: tying

As a final application, we consider a model of tying, which is a variation on the standardization model in the previous section. As an example, the EC's Google Android case (2018) involves tying of Google's search engine with Google's app store on smartphones. For a discussion of the details of this case, see Choi and Jeon (2021) and Etro and Caffarra (2017). In brief, the concern is that Google's app store is essential for Android phone manufacturers; by obliging these manufacturers to also install Google search as the default search engine, Google might foreclose access to end users for rival search engine producers.

An important difference with the analysis above is that contracts between app producers (including Google) and phone manufacturers may also include monetary transfers. We therefore include the possibility of transfers among the monopolist and the entrant into our model. In practice, these transfers would be mediated through bilateral contracts with phone manufacturers.

In line with much of the literature on tying, we consider a setting with homogeneous consumers, rather than one in which valuations are distributed according to some distribution F. Hence, this is not a direct application of our general framework in Section 2: in this monopolistic setting, we are able to make our point in a much simpler model.

Consider the following set-up. A monopolist provides a 'system' A, for which it is the only producer, and an 'app' $B1$. In addition, in the app market, there are several competitive rival app producers, each producing their version $B2$ of that app. A unit mass of consumers value A at v_A, $B1$ at v_{B1}, and, for simplicity, all rival $B2$s are valued at v_{B2}. Moreover, they prefer any rival app $B2$ to $B1$, so $v_{B2} > v_{B1}$. Denote $\Delta \equiv v_{B2} - v_{B1}$. To be able to use either $B1$ or one of the $B2$, consumers need system A. Consumers have unit demand for the app, so buy at most one app. For simplicity, marginal costs for all products are equal to zero.

As a benchmark, we will look at the situation without advertising. First, consider the case without tying. The – more valuable – apps $B2$ will enter the market and will compete down to marginal costs. The equilibrium has $p_{B2} = 0$, and $p_A = v_A + v_{B2} = v_A + v_{B1} + \Delta$; since system A is indispensible for using the app, the monopolist can cream off the additional rents offered by the higher value rival apps through a higher price for the system. In equilibrium, consumers buy A and one of the $B2$, leaving the monopolist with profits $\pi_A = v_A + v_{B1} + \Delta$. Conversely, by tying the sale of A to $B1$, the monopolist does worse. It can now charge at most $p = v_A + v_{B1}$ for the combined system and app. This is the Chicago critique.

As noted by Choi and Jeon (2021), this argument breaks down when there are advertising rents to be gained. Let us assume that all ad impressions are equally valuable first: suppose that π_m can be earned from advertisements, both on A as well as B, in line with our notation in Section 2. Hence, we assume that the system can also provide access to advertisers itself – perhaps through other apps provided by the monopolist, unrelated to $B1$ or $B2$.[19] With tying, the monopolist could charge $p = v_A + v_{B1}$ and resulting profits would be $\pi_A = v_A + v_{B1} + 2\pi_m$, earning advertising rents through both channels.

Without tying, and if app prices could be negative, app producers would compete in selling to consumers and accessing the advertising rents π_m, driving equilibrium prices down to $p_{B2} = -\pi_m$. The monopolist will again capture the additional rents for consumers $\pi_m + \Delta$, in the form of a mark-up on its system price, $p_A = v_A + v_{B1} + \Delta + \pi_m$. Combined with its advertising income through A, this yields profits $\pi_A = v_A + v_{B1} + \Delta + 2\pi_m$. Again tying is the worse outcome for the monopolist.

With a nonnegativity constraint on app prices however, the rivals can only reduce prices down to $p_{B2} = 0$ which in turn implies that the monopolist can only charge $p_A = v_A + v_{B1} + \Delta$, so its profits would equal $\pi_A = v_A + v_{B1} + \Delta + \pi_m$, including only the advertising rents through its own system. The monopolist is now not able to extract $B2$'s advertising rents through a higher p_A. As a result, tying strictly increases its profits if ad profits are sufficiently large, $\pi_m > \Delta$. This is the main argument in Choi and Jeon (2021).

This consequence of the nonnegativity constraint on consumer prices is undone, however, if we allow for side payments between rival app producers and monopolist (see Choi and Jeon, 2021, section IV.F). In that case, the monopolist will be better off selling system access to the entrants in the form of a transfer of $t = \pi_m$ for each user of app $B2$ that it allows on the platform. Now, equilibrium prices again equal $p_{B2} = 0$ and $p_A = v_A + v_{B1} + \Delta$ but through the transfer, profits of the monopolist would be back at $\pi_A = v_A + v_{B1} + \Delta + 2\pi_m$ so it would refrain from tying.[20]

Tying reappears as the dominant strategy if we allow for a singlehoming premium $R > \Delta$: the first impression of an ad is worth $\pi_s = \pi_m + R$ to advertisers. With tying, the monopolist would again set $p = v_A + v_{B1} + \Delta$, now earning $\pi_A = v_A + v_{B1} + 2\pi_m + R$.

[19] In the Android example, the system not only gets access to consumers through its search app, but also, for instance, through a media player.

[20] Following Etro and Caffarra (2017), Choi and Jeon (2021) explore a different route towards reestablishing tying, involving instead a nonpositivity constraint on the system's price.

Since consumers singlehome, the monopolist controls all pricing to advertisers, and can extract the complete value of ad impressions from advertisers. Without tying, conversely, we get $p_{B2} = 0$, with competing app producers willing to pay a transfer up to $t = \pi_m$ to access consumers, as before. With $p_A = v_A + v_{B1} + \Delta$, the monopolist will earn $\pi_A = v_A + v_{B1} + \Delta + 2\pi_m$. Since consumers multihome on the monopolist's and the rival's products, however, the monopolist and app producer can only extract their incremental profits, π_m each, from advertisers. As long as $\Delta < R$, the gain from increased consumer prices would be insufficient to compensate for the loss of the singlehoming premium R for the monopolist. Hence, in this case, we would see tying in equilibrium, even if we allow for side payments.

Though we call this tying, it is fair to say that this mechanism has the flavor of the 'contracting with externalities' models to explain traditional vertical exclusion, rather than the predatory notions underlying traditional tying models. The monopolist excludes $B2$ from the market to monopolize the advertising market, gaining R for the industry as a whole, and making this industry-profit-maximizing set-up the equilibrium one, as in Bernheim and Whinston (1998).

7 Conclusion

In this paper, we analyzed the competitive strategies of platforms operating on two-sided markets. We argued that they face a strategic seesaw: the more strongly they choose to compete on the consumer side of the market, the less fierce competition will be on the advertiser side – and vice-versa. Fierce competition on the consumer side induces consumers to singlehome. But when consumers are singlehoming, platforms gain more market power over advertisers. Hence, the more important the singlehoming revenues that can be gained on the advertising side, the more strongly the platforms will choose to compete on the consumer side.

We looked at various strategies that induce consumers to singlehome: offering less differentiated products, diversifying the product portfolio a firm offers, and bundling products.

We also applied the mechanism to give an alternative explanation for tying.

We used advertising as our leading example, but argued that our model applies to any business strategy for which unique access to consumers' eyeballs is profitable. For example, the platform where a consumer singlehomes is able to collect more and better data on that consumer, which also puts it at an advantage over its competitor. We therefore kept the 'advertiser' side as general as possible, only positing there is some additional benefit to a platform from having consumers visit exclusively. Whether this benefit arises from a monopoly over attention, over consumer data, or in being able to directing consumers' search through product referrals is immaterial for this analysis.

To address welfare effects, we would have to be more specific about the structure of the advertising market, also addressing e.g. the nuisance to consumers that advertising causes, and the repercussions on the product markets of advertisers. Another effect that we cannot take into account in our current framework is that of platform quality. More intense competition for consumers, in particular with a zero price constraint, could boost platforms' incentives to provide quality.

It is often argued that antitrust analyses of platform markets should explicitly take their twosidedness into account. For example, charging prices below marginal cost may not be predatory but rather a matter of subsidizing one side of the market to get the other side on board. What our analysis shows is that taking twosidedness into account not only helps us to better understand the pricing strategy of a platform, but also the competitive stance that it takes.

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A Appendix

Proof of proposition 1

Define the volumes of users as V_A, V_B, V_{AB}, V_0, with

$$V_A = Prob\left[u_A = \max\left(0, u_A, u_B, u_{AB}\right)\right] \text{ etc.}$$

The case $R = 0$: In this case, at symmetric prices p, firm A's profit is given by

$$\pi_A(p, \Gamma) = (p - c)(V_A + V_{AB}).$$

For $\Gamma = 0$, independent products, $u_{AB} > u_B$ as long as $u_A > 0$, so sales are made for any consumer with $u_A > 0$, and in particular profits only depend on u_A and not on u_B. For $\Gamma > 0$, the volume of consumers, at the same prices p, will be strictly lower than with $\Gamma = 0$, since those with $0 < u_A < \Gamma$ and $u_B > u_A$ will not be included in the volume.

Take prices p as the symmetric equilibrium price for some $\Gamma > 0$. Then by the above reasoning, $\pi_A(p, \Gamma = 0) > \pi_A(p, \Gamma)$. Since at $\Gamma = 0$, A's profits no longer depend on u_B, in the $\Gamma = 0$ equilibrium prices p^* are chosen to maximize own profits. As a result,

$$\pi_A(p^*, \Gamma = 0) \geq \pi_A(p, \Gamma = 0) > \pi_A(p, \Gamma).$$

The case R large: First, for $\Gamma = 1$, no consumers consume both products AB. At $p = 0$, half of consumers consumer A, the other half B, and industry profits are $R - c$, with each firm obtaining half of that. For $R > \max(2 + c, 2)$, $p = 0$ is the equilibrium: a deviation to $p > 0$ always reduces profits: consumer volume decreases, and $p = 1$ is the choke price, so the loss in R-income will always dominate the gain from p-income.

Next, we prove that for any $\epsilon > 0$, choosing $\Gamma < 1 - \epsilon$ will lead to lower firm profits than $\frac{R}{2}$, for R sufficiently large. We do so by showing that maximum *industry* profits for such lower Γ in any symmetric configuration are dominated by these $\Gamma = 1$ profits.

So assume $\Gamma < 1 - \epsilon$. Industry profits at symmetric prices p are given by

$$\pi = (p - c + R)(1 - V_0) + (p - c - R)V_{AB}$$

If $p \leq \frac{\epsilon}{2}$ we have that at least some consumers will multihome, V_{AB} will be positive, $V_{AB} = (1 - F(p + \Gamma))^2 > \frac{\alpha^2\epsilon^2}{4}$. Here, $\alpha > 0$ is the minimum of $f(v)$. Hence

$$\pi < (p - c + R) + (p - c - R)\frac{\alpha^2\epsilon^2}{4} < 2(p - c) + R - R\frac{\alpha^2\epsilon^2}{4}$$

Now choose $R > \max(c, \frac{8}{\alpha^2\epsilon^2}, \frac{8(1-\frac{c}{2})}{\alpha^2\epsilon^2})$ (note c might be positive or negative), so that we get

$$\pi < R + \epsilon - 2c - 2(1 - \frac{c}{2}) = R - c + \epsilon - 2 < R - c$$

showing industry profits are lower than industry profits at equilibrium for $\Gamma = 1$.

Conversely, for $p \geq \frac{\epsilon}{2}$, it might be that no consumers multihome even though $\Gamma < 1$. But in this case,

$$\pi \leq (p - c + R)(1 - V_0) = (p - c + R)(1 - F^2(p)) < (1 - c + R)(1 - \alpha^2 p^2)$$
$$< (1 - c + R)(1 - \alpha^2 \epsilon^2/4) = R - c - (1 - c)\frac{\alpha^2 \epsilon^2}{4} - R\frac{\alpha^2 \epsilon^2}{4} < R - c - 1$$

where the last inequality again follows from having chosen $R > \max(\frac{8}{\alpha^2 \epsilon^2})$.

In conclusion, profits at any $\Gamma < 1 - \epsilon$ are always dominated by equilibrium profits at $\Gamma = 1$ for R sufficiently large.

Q.E.D.

Proof of proposition 2

The case $R = 0$: For the configuration of an AB firm competing with an $A'B'$ firm, we have two separate competitive duopolies, one for the A-type products, the other for the B-type products. Let us call the resulting duopoly equilibrium price p_D; in the symmetric equilibrium, all four products are sold at the same price, and each firm sells to half of each market.

Looking instead at the AA' and BB' firms, we see these are no direct competitors, and $R = 0$ their profits are not affected by their rival's pricing. Each firm could choose to set prices equal to p_D, leading to the exact same volumes and profits as for the AB mergers. However, firms can unilaterally adapt prices to optimize profits, and their monopoly profits strictly dominate.

The case when R is large: For the AB merger case, we have two duopolies, leading to $p = 0$ pricing in each market for R large, as in proposition 1. In that equilibrium, both firms get half the A-market and half the B market. These halves being independent, each firm has 1/4 single-homing consumers, so that, wit $p = 0$, $\pi_{AB} = R/4$.

On the other hand, for the AA'-firm competing with BB'. Let us denote the total market covered by the AA' firm as V_A, so, with symmetric prices p,

$$V_A = 1 - F^2(p).$$

Then profits for the AA' firm are

$$\pi_{AA'} = (p-c)V_A + RV_A(1-V_B)$$

In the symmetric equilibrium, where $V_A = V_B$, we find the first-order condition for an interior solution

$$V_A = -\frac{p-c+R}{p'-R}, \quad \text{with} \quad p' = 1/\frac{dV_A}{dp} = -\frac{1}{f(p)F(p)}.$$

Since $f(p) > \alpha$ for any p, we find that as $R \to \infty$, $V_A \to 1$, so that $V_A(1-V_B)$ will go to zero for R big. As a result, in the limit for large R, in the symmetric equilibrium $\pi_{AB} > \pi_{AA'}$.

Q.E.D.

Proof of proposition 3

The case $R = 0$ corresponds to the bundling model in Zhou (2017), who proves (Proposition 1.i) that standardization always produces higher profits than incompatibility for two firms.

The case when R is large: we have two duopolies, leading to $p = 0$ pricing in each market for R large, as in proposition. In that situation, profits are $\frac{R}{2}$ for bundling versus $\frac{R}{4}$ for compatibility.

Q.E.D.