The exclusionary effects of addictive platforms

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Abstract

We model competition between an addictive and non-addictive social media platform in the presence of network affects and three types of consumers. Irrational consumers become addicted (overuse a platform) without safeguards but do not realize this is harmful. Invulnerable consumers know their optimal level of use and always conform to it. Vulnerable consumers rationally perceive their risk of addiction but lose self-control when joining an addictive platform. We consider platform competition over addiction safeguards and over quality. We find that there can be equilibria where one platform dominates the market or where they share it and study the consequences for consumer welfare. An addictive platform can exclude a non-addictive rival from the market even when network effects are small and the non-addictive platform moves first.

1 Introduction

There has been rising concern about people becoming addicted to social networks and social media platforms possibly deliberately encouraging this with addictive design such as infinite scrolling, constant alerts and notifications, and exploitation of human vulnerabilities of needing to reciprocate social gestures (Neyman (2017); Turel and Osatuyi (2017)). In a model with fully rational consumers, one would think that a social media platform without addictive properties would gain a competitive advantage. If not all consumers recognize the risk of addiction, however, we might worry that network effects could induce consumers who recognize the risk of addiction to prefer an addictive platform because it has more consumers on it.

To explore this issue, we develop a model of competition between social media platforms that features both addiction and network effects. We characterize competition between a platform that has controls to prevent addiction (a non-addictive platform) and one that does not (an addictive platform) and study platforms' incentives to become addictive. We have three types of consumers. Irrational consumers always select the addictive platform because they (irrationally) believe that the addictive level of use is optimal for themselves. We then have two types of "rational" consumers. Group 1 (or invulnerable) consumers are both rational and have perfect self-control, so they run no risk of addiction. Group 2 (or vulnerable) consumers are rational in the sense that they recognize that by joining the addictive platform they might lose self-control and become addicted, with a sub-optimally high level of use. Such differences among consumers are consistent with Allcott et al (2022)'s randomized experiment showing that self-control problems explain 31% of social media use and that consumers are heterogeneous with regard to the degree of their self-control problems. All consumers in our model also benefit from network effects–the value of a platform to a user is increasing in the number of users.

We then consider two different types of competition. Consistent with current social media platforms, we assume that platforms do not charge users but make revenue from advertisers. This ad revenue is proportional to the total use of the platform (number of consumers times average use per consumer). Thus, addicted consumers are, all else equal, more profitable for a platform. Platforms can compete for consumers in two ways (which in our base model we consider separately). First, we assume that the addictive platform can compete for consumers by becoming less addictive (limiting the total use for every consumer). Second, we analyze competition through adding content or features to the platform that do not affect addiction. We assume platforms' investment in this form of competition constitutes a fixed cost, making this form of competition similar to an all-pay auction, when the game is simultaneous, and to an incumbent-entrant game, when platforms move sequentially.

For both types of competition, we find that there can be equilibria in which the addictive platform monopolizes the market, equilibria in which only vulnerable consumers join the non-addictive platform, and equilibria in which all rational consumers use the non-addictive platform. When the locus of competition is the level of addictiveness, we show that, taking the existence of the addictive platform as given, consumer welfare is greater when rational consumers all use the addictive platform, rather than when they are split, eventhough that means the non-addictive platform is completely excluded. When the locus of competition is the quality of the platform, a similar result emerges for small network effects. Here, low market segmentation (i.e., when the gap in preferences between vulnerable and invulnerable consumers is not large) implies higher investment in quality and monopolization of the market by the addictive platform. For large network effects, however, exclusion of the non-addictive platform by the addictive one can be associated with lower investment in quality, even for low market segmentation. We also find that by using its addictive nature, the addictive platform can exclude the non-addictive platform from the market even when the non-addictive platform has a first-mover advantage. This follows because of the addictive platform's extra ad-revenue generated by the socially excessive use of the platform. In order to compete with the addictive platform, the non-addictive platform needs to invest in quality matching this high ad revenue, and its own ad revenue is smaller, precisely because it is not addictive.

In this preliminary draft, we have begun studying an earlier stage, where platforms choose whether to be addictive or not. Our motivation is that in cases where the wrong platform, from the point of view of consumers, excludes the other, it would be sound policy to prohibit such exclusionary behavior. When the wrong platform is the addictive one, due to its socially excessive level of use, this outcome can obviously be prevented by a rule prohibiting addictive platforms. Absent such a blunt prohibition, antitrust rules could be used to condemn such exclusion as illegal monopolization: When the addictive nature of the platform drives the exclusion, such a result is consistent with current antitrust doctrine. Indeed, we find that the larger is addiction-generated ad revenue, the higher the prospects of monopolization of the market by the addictive platform. We also find that this extra ad-revenue is never transferred to consumers when an addictive platform excludes a non-addictive platform, regardless of how fierce competition between them over consumers is.

There is an extensive literature related to network effects and platform competition, and a sparse literature relating these to addiction. In the context of platform competition with network effects and without addiction, we contribute especially to the strand of this literature studying different types of networks competing over heterogeneous consumers, such as Fudenberg and Tirole (2000); Chen and Tse (2008); Jullien (2011); Hosain and Morgan (2013); Halaburda and Yehezkel (2016); Markovich and Yehezkel (2023) and Akerlof et al (2023).

A line of the platform literature related to the latter strand we contribute to is that which studies heterogeneous consumers possibly splitting among different platforms at the expense of network effects (e.g., Chen and Tse (2008); Hosain and Morgan (2013); Halaburda and Yehezkel (2016) and Biglaiser and Crémer (2020)). In our framework, however, for high enough addiction-generated ad revenue, the addictive platform can exclude the non-addictive one even from serving vulnerable consumers.

We also contribute to literature studying platform behavior vis a vis boundedly rational consumers. Hosain and Morgan (2013) study competition between two-sided platforms matching between the two sides and characterize equilibria in which more rational consumers herd with less rational consumers. Their is no addiction in their model. Liu et al (2021) study a platform's data sharing decisions when some consumers lack self-control when facing targeted ads by temptation goods. Ichihashi and Kim (2023) study platform competition over the time-allocation of a single consumer, who loses self-control once he joins a platform. The competing platforms choose how addictive to be. There are no network effects in these papers.

Bhargava (2023) studies competition between an ad-revenue based addictive platform and a subscription-fee based non-addictive platform over a continuum of heterogeneous consumers where some lack self-control. He studies how such competition affects the level of addictiveness and investment in content and models network effects as exacerbating the addictive platform's advantage. He also offers a mechanism of taxing addictive platforms to subsidize non-addictive ones. Our paper contributes to his work in various ways. First, Bhargava (2023) assumes consumers are atomistic and non-strategic while in our framework there is a strategic interplay among consumers. This enables us to consider how different levels of network effects influence the strategic interplay between the platforms and among the consumer groups. Second, we plan to endogenize platforms' decisions whether to become addictive while he assumes these choices are exogenous. Accordingly, we wish to draw policy implications regarding the use of addictiveness of the platform as an exclusionary device.

The next section describes the model. Section 3 discusses how different consumer groups choose platforms. Section 4 analyzes competition between an addictive and a non-addictive platform. Section 4.1 focuses on the case when the addictive platform can compete by choosing its level of addictiveness. Section 4.2 studies the case of competition over investment in beneficial platform features. Section 5 discusses extensions we wish to include in future drafts and Section 6 concludes.

2 Model

In the absence of platform imposed constraints, consumers can use a social media platform at intensity level $x \in [0, h]$. Consumer utility is given by $u(x, z)$, is single peaked and is maximized at $u(l, z)$ for any z (which represents the size of the platform), where $l \ll h$. Assume $u(x, z) = 0$ for $x = 0$ or $z = 0$. The social media platform can have addictive effects. We call a social media platform that did not constrain the level of its use to no more than l an addictive platform. The social media platform can (with no direct cost) put an exogenous limit of l on use if it so chooses. We call a network that has implemented such a limit a non-addictive platform. A fraction $1 - \alpha$ of consumers ("the irrational consumers") wrongly believe that $u(x, z)$ is maximized at $u(h, z)$ for any z. We call this group of consumers group

"I". For simplicity, we assume network effects are linear. That is, $u(x,z) = v(x) + \gamma z$.

The remaining fraction α, who do realize ex ante that utility is maximized at $u(l,z)$ (we call them "rational consumers"), are divided into two groups: A fraction α_2 have a probability p of losing self-control after joining an addictive platform and engaging in excessive use of $x = h$ ($0 < p < 1$). We call these group 2 consumers. The remaining fraction, α_1, we call group 1 consumers. Group 1 has perfect self-control, so they will always choose $x = l$. Hence $\alpha_1 + \alpha_2 = \alpha$. Accordingly, the expected utility of a group 2 consumer from joining the addictive platform is $pu(h,z) + (1-p)u(l,z)$. Group 1 consumers' utility from joining any platform is $u(l,z)$. We assume all consumers maximize their perceived expected utility. We assume that each group of consumers always coordinates on the same platform.

3 Group platform choices

Consider consumers' choices given that there is one addictive and one non-addictive platform and assume for now that the platforms do not engage in any strategies to compete over consumers. We assume that group I consumers always join the addictive platform, either because they don't realize other consumers' preferences for the non-addictive one or because their distaste for the non-addictive one is prohibitively large. Group 2 chooses the addictive platform rather than none at all if and only if:

$$(1-p)v(l) + pv(h) + \gamma \geq 0$$

Group 2 chooses the addictive platform over being in the non-addictive platform by itself if and only if:

$$(1-p)v(l) + pv(h) + \gamma \geq v(l) + \gamma\alpha_2$$

that is, if network effects are sufficiently large:

$$\gamma \geq \frac{p(v(l) - v(h))}{1 - \alpha_2} \equiv \widehat{\gamma} \tag{1}$$

Group 2 prefers being in the addictive platform with everyone else to being in the non-addictive platform with group 1 if and only if:

$$(1 - p)v(l) + pv(h) + \gamma \geq v(l) + \gamma\alpha$$

That is, if and only if network effects are even larger:

$$\gamma \geq \frac{p(v(l) - v(h))}{1 - \alpha} \equiv \check{\gamma} > \widehat{\gamma} \tag{2}$$

This yields the following lemma:

Lemma 1. *(i) If $\gamma \geq \widehat{\gamma}$, then there is an equilibrium in which both group 1 and group 2 choose the addictive platform, giving group 1 the maximal utility of $v(l) + \gamma$.*

(ii) If $1 - \alpha > \alpha_2$, then in any equilibrium, group 1 chooses the addictive platform; group 2 follows if and only if $\gamma \geq \widehat{\gamma}$.

(iii) If $1 - \alpha \leq \alpha_2$, then:

a. If $\gamma < \widehat{\gamma}$, the unique equilibrium has both groups 1 and 2 choose the non-addictive platform;

b. If $\gamma \in (\widehat{\gamma}, \check{\gamma}]$, then groups 1 and 2 both choosing either platform is a coalition-proof equilibrium.

c. If $\gamma > \check{\gamma}$, the only coalition proof equilibrium is all consumers choosing the addictive platform.

Proof. Proof of part (i): If $\gamma \geq \widehat{\gamma}$ and both groups choose the addictive platform, then group 1 obtains its maximal utility, so it has no incentive to deviate. Given that group 1 and the irrationals are on the addictive platform, $\gamma \geq \widehat{\gamma}$ ensures that group 2 prefers to join the addictive platform than be alone on the non-addictive platform.

To prove part (ii), if $1 - \alpha > \alpha_2$, then group 1 always receives greater network benefits from the addictive platform, so it will join that platform. Group 2's decision then depends on whether or not $\gamma \geq \widehat{\gamma}$.

To prove part (iii), if $1 - \alpha \leq \alpha_2$, then group 1 receives greater network benefits from joining group 2 than joining the irrationals. If it believes group 2 will join the non-addictive platform, then it will as well. That is the only reasonable belief if $\gamma < \widehat{\gamma}$, making it the unique equilibrium in this case, thereby proving part (iii)(a). To prove part (iii)(b), if $\gamma \in (\widehat{\gamma}, \check{\gamma}]$, then the coalition proof equilibrium depends on which group rational consumers believe controls the equilibrium. If it is group 1, then group 2 joins group 1 in the addictive platform, because $\gamma > \widehat{\gamma}$. If group 2 controls the equilibrium, it prefers to lure group 1 to the non-addictive platform, because $\gamma < \check{\gamma}$. Both equilibria are coalition proof, because group 1 does not wish to deviate with group 2 in the former, and group 2 does not wish to deviate with group 1 in the latter. To prove part (iii)(c), if $\gamma \geq \check{\gamma}$, while there is an equilibrium in which all rational consumers believe they will all join the non-addictive platform, this is not coalition proof, because it is worse for both group 1 and group 2 than both of them joining the addictive platform. $\square$

4 Asymmetric platform competition

Section 3 considers groups' choice between platforms assuming platforms do not engage in competitive strategies to steal consumers from one another. In this section, we allow for platforms to affect consumers' utility in order to influence their choice. In this preliminary version, we study two types of competitive strategies: an endogenous choice of h by the addictive platform, and investment by the platforms in quality improvements unrelated to addiction.

4.1 Endogenous h

In this case, we consider a non-addictive platform that caps all use at l (the (true) utility maximizing choice of use) and an addictive platform that can choose to cap use at any $h \leq \overline{h}$. Assume that $\overline{h}$ is large enough so that $(1-p)v(l)+pv(\overline{h})+\gamma < v(l)+\gamma\alpha_2$; hence, at $\overline{h}$, group 2 prefers the non-addictive platform even if it is the only group on that platform (compared to being on the addictive platform with the entire population). For any γ, there will exist an $h(\gamma) < \overline{h}$ such that $(1-p)v(l)+pv(h(\gamma))+\gamma = v(l)+\gamma\alpha_2$. It is easy to see that $h'(\gamma) > 0$; when network effects are larger, group 2 consumers will be willing to risk a greater level of addictive use to choose the addictive platform rather than be the only consumers on the non-addictive platform.

To determine an addictive platform's optimal choice of h, we first must specify platforms' profit functions. For simplicity, we will assume that platforms earn revenues from advertising that are a function of the total use of their platform. Thus, the platforms' profits depend on both the number of consumers that use the platform and the intensity of their use. Accordingly, the non-addictive platform's profits when serving all rational consumers and only group 2 are $\pi_1 \equiv \alpha lr; \pi_2 \equiv \alpha_2 lr$, respectively. Because the non-addictive platform chooses use level l, it's revenues are proportional to the number of consumers that joined it. For the addictive platform, profits are:

$$\pi^A_{all}(h) \equiv \{(1-\alpha+p\alpha_2)h + [\alpha_1 + (1-p)\alpha_2]l\}r$$

$$\pi^A_{I1}(h) \equiv \{(1-\alpha)h + \alpha_1 l\}r$$

$$\pi^A_{I}(h) \equiv \{(1-\alpha)h\}r$$

where $\pi^A_{all}(h)$, $\pi^A_{I1}(h)$ and $\pi^A_{I}(h)$ are the addictive platform's profits from serving all consumers, irrationals and group 1, and only irrationals, respectively. The addictive platform always serves irrational consumers and these consumers will always use the platform at the maximum allowable level, h. If group 1 consumers also join this platform, this adds another $\alpha_1 l$ level of use. If group 2 consumers join as well, then with probability p they use at level h and with probability $1-p$, they use at level l.

Notice that if the addictive platform is going to only serve irrational consumers, it should choose $h = \overline{h}$. Furthermore, if $1-\alpha \geq \alpha_2$, then the addictive platform can capture all consumers other than group 2 at $h = \overline{h}$. But, if the addictive platform wants to capture group 2 consumers (and, potentially avoid losing group 1 that may follow group 2 to the non-addictive platform when $1-\alpha < \alpha_2$) it will have to reduce h to a level lower than $\overline{h}$, which depends on the level of network effects, γ. Denote this level of h by $h(\gamma)$. This level also depends on whether there are more irrational consumers than vulnerable ones or vice versa, as demonstrated below.

4.1.1 More irrational consumers than vulnerable ones

If $1-\alpha \geq \alpha_2$, then the addictive platform chooses $\overline{h}$ instead of $h(\gamma)$ if and only if:

$$\pi^A_{I1}(\overline{h}) > \pi^A_{all}(h(\gamma))$$

or

$$h(\gamma) < \overline{h} - \alpha_2 \frac{p\overline{h} + (1-p)l}{1-\alpha+p\alpha_2} \tag{3}$$

Because $h'(\gamma) > 0$, this means that there exists a $\overline{\gamma}$ such that, when $1-\alpha \geq \alpha_2$, the addictive platform chooses $\overline{h}$ instead of $h(\gamma)$ if and only if $\gamma < \overline{\gamma}$. This gives us the following result.

Proposition 1. *If there are at least as many irrational consumers as vulnerable ones (i.e., $1-\alpha \geq \alpha_2$) then there can be an active non-addictive platform if and only if network effects are sufficienlty small, $\gamma < \overline{\gamma}$. If consumption utility is linearly decreasing above use level l, then at $\overline{\gamma}$, actual consumer welfare is strictly greater in the equilibrium with only one platform* *and maximal use level of $h(\overline{\gamma})$ than with both platforms with maximal use of $\overline{h}$ and l.*

Proof. If $\gamma < \overline{\gamma}$, then in presence of a non-addictive platform, the addictive platform earns more by not trying to capture group 2 consumers, so group 2 consumers will choose the non-addictive platform. On the other hand, if $\gamma \geq \overline{\gamma}$, the addictive platform will reduce the maximum use level to induce group 2 consumers to choose it. At $\gamma = \overline{\gamma}$, (actual) consumer welfare from having only an addictive platform is $(1-\alpha+p\alpha_2)v(h(\overline{\gamma}))+(\alpha_1+(1-p)\alpha_2)v(l)+\overline{\gamma}$. Actual consumer welfare from having both active platforms is $(1-\alpha)v(\overline{h}) + \alpha v(l) + [(1-\alpha_2)^2 + \alpha_2^2]\overline{\gamma}$. Actual consumer welfare is greater from having two active platforms at the cutoff level of network effects if and only if:

$$p\alpha_2[v(l) - v(h(\overline{\gamma}))] - (1-\alpha)[v(h(\overline{\gamma})) - v(\overline{h})] - 2\alpha_2(1-\alpha_2)\overline{\gamma} > 0$$

If the consumption utility function is linearly decreasing above l (i.e., $v(x) = z(k-x)$ for any $z > 0, x > l$ and any k) this never holds. The above expression becomes $-\alpha_2[2(1-\alpha_2)\overline{\gamma} + lz] < 0$. □

Proposition 1 highlights that when there are more irrational consumers than vulnerable ones, the addictive platform can try to capture the entire market by making it's platform somewhat less addictive in order to induce the vulnerable consumers to use it (and gain larger network benefits) rather than choose the non-addictive platform. The larger are the network effects, the less it will have to reduce the maximal use level to do so. Because reducing the maximal use level sacrifices profits from the irrational consumers, the addictive platform will only attempt to capture vulnerable consumers if network effects are sufficiently large that it doesn't have to reduce the maximal use level too much.

At the level of network effects for which the addictive platform is indifferent between the strategy of reducing the maximal use to capture the entire market and ceding the vulnerable consumers to the non-addictive platform, social welfare is greater (at least for linear utility) when the (somewhat less) addictive platform controls the market than when it splits the market with the non-addictive platform. Intuitively, when the addictive platform is indifferent between setting $\overline{h}$ and $h(\gamma)$, group 1's use and the irrational's excess use of $\overline{h}$ when serving only them yields ad revenue equal to the ad revenue from serving all consumers at use level $h(\gamma)$. But this implies that when the addictive platform captures the entire market and steals group 2 consumers from the non-addictive platform, the total level of use goes down. Since all consumers are using at least level l, the reduction in total use leads to greater actual consumption utility. On top of this, there are greater network benefits from one platform capturing the entire market rather than splitting the market between the two platforms.

4.1.2 More vulnerable consumers than irrational ones

Now consider the case where $1 - \alpha < \alpha_2$. Here, if the vulnerable (group 2) consumers choose the non-addictive platform, then the invulnerable consumers (group 1) will do the same. This means there is a range of h for which both groups 1 and 2 will choose either platform as long as they are choosing the same one. In this range, group 2 will prefer they coordinate on the non-addictive platform while group 1 prefers they coordinate on the addictive platform (to generate greater network effects).

If group 1's preferences control the equilibrium, then condition (1) will again determine the equilibrium, so that the addictive platform can capture the entire market by limiting use to $h(\gamma)$. The difference from the prior case is that if the addictive platform chooses not to limit use to $h(\gamma)$, then it will lose both groups 1 and 2 to the non-addictive platform. Thus, the addictive platform chooses $\overline{h}$ instead of $h(\gamma)$ if and only if:

$$\pi_I^A(\overline{h}) > \pi_{all}^A(h(\gamma))$$

or

$$h(\gamma) < \overline{h} - \frac{\alpha l + p\alpha_2(\overline{h} - l)}{(1 - \alpha + p\alpha_2)} = l + \frac{\overline{h}(1 - \alpha) - l}{(1 - \alpha + p\alpha_2)} \tag{4}$$

Notice that this is strictly smaller than the condition for $h(\gamma)$ in (3) when there were more irrationals than vulnerables. That is, when there are more vulnerable consumers and group 1's preferences control the equilibrium, the addictive platform is more likely to want to compete vigorously over group 2 consumers and monopolize the market even if that means making the platform less addictive. Notice, that according to (4), if the fraction of irrational consumers is sufficiently small ($(1-\alpha) \leqslant \frac{l}{h}$), the addictive platform would be willing to reduce the maximum use all the way down to l if necessary to attract group 2 consumers. We have the following result:

Proposition 2. *If there are fewer irrational consumers than vulnerable ones ($1 - \alpha < \alpha_2$) and group 1 controls the equilibrium, then there can be an active non-addictive platform if and only if network effects are sufficienlty small, $\gamma < \widetilde{\gamma} < \overline{\gamma}$ (a smaller threshold than when $1-\alpha > \alpha_2$). If consumption utility is linearly decreasing above use level l, then at $\widetilde{\gamma}$, actual consumer welfare is strictly greater in the equilibrium with only one platform and maximal use level of $h(\widetilde{\gamma})$ than with both platforms with maximal use of $\overline{h}$ and l.*

Proof. The proof of the first claim follows from the analysis in the text and steps analogous to those in the proof of Proposition 1. $\widetilde{\gamma} < \overline{\gamma}$ follows because $h' > 0$ and $\overline{h} - \frac{\alpha l + p\alpha_2(\overline{h}-l)}{(1-\alpha+p\alpha_2)} < \overline{h} - \alpha_2 \frac{p\overline{h}+(1-p)l}{1-\alpha+p\alpha_2}$ because $(\alpha - p\alpha_2)l > (\alpha_2 - p\alpha_2)l$, since $\alpha_1 > 0$. At $\gamma = \widetilde{\gamma}$, (actual) consumer welfare from having only an addictive platform is $(1-\alpha+p\alpha_2)v(h(\widetilde{\gamma}))+(\alpha_1+(1-p)\alpha_2)v(l)+\widetilde{\gamma}$. Actual consumer welfare from having both active platforms is $(1-\alpha)v(\overline{h}) + \alpha v(l) + [(1-\alpha)^2 + \alpha^2]\widetilde{\gamma}$. Actual consumer welfare is greater from having two active platforms at the cutoff level of network effects if and only if:

$$p\alpha_2[v(l) - v(h(\widetilde{\gamma}))] - (1-\alpha)[v(h(\widetilde{\gamma})) - v(\overline{h})] - 2\alpha(1-\alpha)\widetilde{\gamma} > 0$$

If the consumption utility function is linearly decreasing above l (i.e., $v(x) = z(k-x)$ for any $z > 0, x > l$ and any k) this never holds. The above expression becomes $-\alpha[2(1-\alpha)\widetilde{\gamma}+lz] < 0$. □

If group 2 controls the equilibrium, then as shown in Lemma 1, for any given level of maximal use, there must be greater network effects for the addictive platform to capture the entire market. This means that for any given level of network effects, the addictive platform must reduce the maximal use level to a lower level than in (4) to capture the market. But, because the proof of Proposition 2 holds for any increasing function h, the results carry over to this case as well. The only difference is that the required level of network effects in which the addictive platform is indifferent will be larger because this h function is strictly smaller for all γ than the one where group 1 controls the equilibrium. The next corollary follows immediately:

Corollary 1. *If group 2 controls the equilibrium and $1-\alpha < \alpha_2$, the results from Proposition 2 continue to hold, except that there can be an active non-addictive platform if and only if network effects are sufficienlty small, $\gamma < \widetilde{\gamma}'$, where $\widetilde{\gamma}' > \widetilde{\gamma}$.*

4.2 Quality competition

Consider now the case where the locus of competition is the quality of the platform. Suppose that in period 1, each platform decides how much to invest in quality, and then, after platforms' quality levels are determined, consumers decide what platform to join. Such quality competition can take the form of investment in features that make users' experience more enjoyable (e.g., speed, storage, interface, etc.) while not affecting group 2's probability of becoming addicted or the level of excessive use when addicted. For simplicity, say every dollar a platform invests in quality translates into a dollar of utility to consumers who join this platform. Denote the addictive platform's investment in quality as Q^a and the non-addictive platform's corresponding investment as Q^{na}.

If the platforms choose quality simultaneously, the game looks similar to that of an asymmetric all-pay auction, with the caveat that each firm's bid (their level of quality) affects the results of two different auctions with different levels of asymmetries. The equilibrium will be in mixed strategies. We leave this for the next draft of the paper. Below, we assume platforms move sequentially. As in the previous section, we distinguish between the case where there are more irrational consumers than vulnerable consumers and vice versa.

4.2.1 More irrational consumers than vulnerable ones

Here, absent platforms' investment in quality, by Lemma 1 group 1 consumers prefer the addictive platform. If network effects are small such that $\gamma < \widehat{\gamma}$, group 2 sticks to the non-addictive platform in the absence of investment. Group 1's extra utility from the addictive versus the non-addictive platform is $v(l) + \gamma(1-\alpha_2) - [v(l) + \gamma\alpha] = \gamma(1-\alpha-\alpha_2) \equiv d_1$. Group 2's' extra utility from the the non-addictive versus the addictive platform, assuming group 1 is on the addictive platform, is $p[v(l) - v(h)] - \gamma(1-\alpha_2) \equiv d_2$.

The platforms' gross profit from capturing group 1 is $\alpha_1 lr \equiv \pi_1$. The non-addictive platform's gross profit from capturing group 2 is $\alpha_2 lr \equiv \pi_2$. The addictive platform's gross profit from capturing group 2 is denoted $\alpha_2 r[ph + (1-p)l] \equiv \pi_2' > \pi_2$ because the expected use of group 2 on the addictive platform is greater.

Below we consider separately the case where the addictive platform moves first and the one where the non-addictive platform moves first:

Addictive platform moves first

Say the addictive platform, "A", moves first and chooses quality level Q^a and suppose for now that network effects are small (i.e., $\gamma \leq \widehat{\gamma}$). We have the following result:

Proposition 3. *Suppose that there are more irrational than vulnerable consumers ($1-\alpha \geq \alpha_2$) and network effects are small ($\gamma < \widehat{\gamma}$). In a sequential move quality game in which the addictive platform moves first: (i) if $p[v(l) - v(h)] - \gamma\alpha = d_1 + d_2 < \pi_1 + \pi_2' - \pi_2 = \alpha_1 rl + \alpha_2 rp(h-l)$, then the addictive platform will monopolize the market. Otherwise, the non-addictive platform will serve group 2 consumers.*

(ii) Given that there is an addictive and a non-addictive platform, consumers receive the highest level of quality ($\pi_1 + \pi_2 - d_1$)) if market segmentation is low (i.e., $d_1 + d_2 \leq \pi_1$) and

A monopolizes the market.

Proof. If $Q^a \leq d_2$, then NA's best response is either $Q^{na} = 0$, in which case group 2 consumers choose NA and group 1 consumers choose A, or $Q^{na} = Q^a + d_1$, in which case NA captures both group 1 and group 2 consumers. NA's profit from the first option is π_2; it's profit from the second option is $\pi_1 + \pi_2 - Q^a - d_1$. Of course, A can keep group 1 consumers by inducing NA to offer $Q^{na} = 0$ if $Q^a \geq \pi_1 - d_1$. By so doing, A earns a net profit of d_1 from group 1 consumers. Recall, however, that this equilibrium assumes $Q^a \leq d_2$ (i.e., a case where A allows NA to take group 2), so is only valid if $\pi_1 \leq d_1 + d_2$.

Alternatively, say that $Q^a > d_2$. Now, NA's possible best responses are (i)$Q^{na} = 0$, in which case NA has no consumers and earns zero profit; (ii) $Q^{na} = Q^a - d_2$ so that group 2 consumers choose NA and group 1 consumers choose A, yielding NA a net profit of $\pi_2 - Q^a + d_2$; or (iii) $Q^{na} = Q^a + d_1$, in which case NA captures both group 1 and group 2 consumers, making $\pi_1 + \pi_2 - Q^a - d_1$. NA prefers (iii) over (ii) if and only if $\pi_1 > d_1 + d_2$. In that case, A will only choose $Q^a > 0$ if it makes NA's profit from (iii) non-positive. Any lower investment in quality is ineffective, because it leaves all rational consumers to NA. That requires $Q^a \geq \pi_1 + \pi_2 - d_1$, which gives A a net profit from taking both group 1 and 2 consumers of $\pi_2' - \pi_2 + d_1 > 0$, so A will do so.

But, if $\pi_1 \leq d_1 + d_2$, then NA's best response is either (i) or (ii). It will be (i) if and only if $Q^a \geq \pi_2 + d_2$, giving A a net profit from taking both group 1 and 2 consumers of $\pi_1 + \pi_2' - \pi_2 - d_2$. If, instead, A chooses $Q^a = \pi_1 - d_1$, then we saw above that for $\pi_1 \leq d_1 + d_2$, NA can win group 2 consumers with $Q^{na} = 0$ and A keeps group 1 consumers and earns d_1. So, A will take both group 1 and 2 consumers if and only if $\pi_1 + \pi_2' - \pi_2 > d_1 + d_2$. This is possible even with $\pi_1 \leq d_1 + d_2$ if $\pi_2' - \pi_2$ is large enough. If $\pi_1 < d_1 + d_2 < \pi_1 + \pi_2' - \pi_2$, then, although A serves all consumers, they receive lower quality of $\pi_2 + d_2$. This is more quality than group 2 consumers receive when NA serves it (i.e., when $d_1 + d_2 \geq \pi_1 + \pi_2' - \pi_2$) because in the latter case they receive no quality. It is also more quality than irrational consumers or group 1 consumers receive in this case, because $\pi_2 + d_2 > \pi_1 - d_1$. □

Proposition 3 is affected by the level of $d_1 + d_2$, which can be viewed as the level of segmentation in the market (recall that d_1 is A's relative advantage regarding group 1 consumers while d_2 is NA's relative advantage regarding group 2 consumers). If market segmentation is large, then the platforms will more often offer less quality and just divide the market rather than trying to compete aggressively for the entire market. Conversely, when segmentation is smaller, there is more intense quality competition, so the market is both more likely to tip and consumers obtain the benefit of greater quality. However, when A's extra ad revenue stemming from addictive use $(\pi_2' - \pi_2)$, is sufficiently large, this fierce competition translates into a monopoly position for A. Indeed, the larger is addiction-generated ad-revenue $r(h-l)$, the more likely is A to take the whole market.

Part (i) of Proposition 3 can also be phrased in terms of the level of network effects in the market. Recall that we are dealing now with small network effects, of $\gamma < \widehat{\gamma}$. Since $d_1 + d_2 = p[v(l) - v(h)] - \gamma\alpha$, which is decreasing in γ, the above-mentioned result implies that when network effects are intermediate, in the sense that $\frac{p[v(l)-v(h)]}{\alpha} - \frac{[\alpha_1 rl + \alpha_1 rp(h-l)]}{\alpha} < \gamma < \widehat{\gamma}$, A takes the whole market when it moves first. Conversely, for sufficiently small network effects ($\gamma \leq \frac{p[v(l)-v(h)]}{\alpha} - \frac{[\alpha_1 rl + \alpha_1 rp(h-l)]}{\alpha}$), NA serves group 2 consumers.

Non-addictive platform moves first

Say the non-addictive platform, NA, moves first and chooses quality level Q^{na}. Suppose, as before, that network effects are small ($\gamma \leq \widehat{\gamma}$). This yields the following result:

Proposition 4. *Suppose that there are more irrational than vulnerable consumers* ($1 - \alpha \geq \alpha_2$) *and network effects are small* ($\gamma < \widehat{\gamma}$)*. In a sequential move quality game in which the non-addictive platform moves first:*

(i) If $\pi_2' - \pi_2 \geq d_2$ *then A monopolizes the market, with quality level* d_2*.*

(ii) If $\pi_2' - \pi_2 < d_2$*, then NA is active. In particular:*

(a) If market segmentation is low relative to addiction-generated ad revenue, i.e., $p[v(l) - v(h)] - \gamma\alpha = d_1 + d_2 \leq \pi_2' = \alpha_2 r[ph + (1-p)l]$*, then NA serves groups 1 and 2 with quality*

$\pi_1 + \pi_2' - d_2$, while irrational consumers receive zero investment in quality;

(b) If market segmentation is high relative to addiction-generated ad revenue, i.e., $d_1 + d_2 > \pi_2'$, NA serves group 2 consumers with lower quality than in case (a), $\pi_2' - d_2 < d_1$, while irrational and group 1 consumers enjoy no quality investment from A.

Proof. If $Q^{na} \leq d_1$, then A's best response is either $Q^a = 0$, in which case group 2 consumers choose NA and group 1 consumers choose A, or $Q^a = Q^{na} + d_2$, in which case A captures both group 1 and group 2 consumers. A's profit from the first option is π_1; it's profit from the second option is $\pi_1 + \pi_2' - Q^{na} - d_2$. NA can keep group 2 consumers by inducing A to offer $Q^a = 0$ if $Q^{na} \geq \pi_2' - d_2$. By so doing, NA earns a net profit of $\pi_2 - \pi_2' + d_2$ from group 2 consumers. NA cannot profitably do so if $d_2 < \pi_2' - \pi_2$. Also, recall that this equilibrium assumes $Q^{na} \leq d_1$, so is only valid if $\pi_2' \leq d_1 + d_2$.

If $Q^{na} > d_1$, A's possible best responses are (i) $Q^a = 0$, in which case A has only irrational consumers and earns zero profit from rational consumers; (ii) $Q^a = Q^{na} - d_1$ so that group 2 consumers choose NA and group 1 consumers choose A, and A earns net profit of $\pi_1 - Q^{na} + d_1$; or (iii) $Q^a = Q^{na} + d_2$, in which case A captures both group 1 and group 2 consumers, and A's net profit is $\pi_1 + \pi_2' - Q^{na} - d_2$. A prefers (iii) over (ii) if and only if $\pi_2' > d_1 + d_2$. In that case, NA will only choose $Q^{na} > 0$ if it pushes A's profit from (iii) to be non-positive (otherwise, A will serve all rational consumers and NA makes zero profits). That requires $Q^{na} \geq \pi_1 + \pi_2' - d_2$, which gives NA a net profit from taking both group 1 and 2 consumers of $d_2 - (\pi_2' - \pi_2)$. If this is positive, then NA will invest to capture both groups. Otherwise, NA will invest zero and A will capture both groups with quality level d_2.

But, if $\pi_2' \leq d_1 + d_2$, then A's best response is either (i) or (ii). It will be (i) if and only if $Q^{na} \geq \pi_1 + d_1$, giving NA a net profit from taking both group 1 and 2 consumers of $\pi_2 - d_1$. If, instead, NA chooses $Q^{na} = \pi_2' - d_2$, then we saw above that for $\pi_2' \leq d_1 + d_2$, A wins group 1 consumers with $Q^a = 0$, and NA gets group 2 consumers and earns $d_2 - (\pi_2' - \pi_2)$. NA will take both group 1 and 2 consumers if and only if $\pi_2' > d_1 + d_2$, which is inconsistent with the conditions for this case. Hence, for $\pi_2' \leq d_1 + d_2$, NA either serves only group 2 (if

$\pi_2' - \pi_2 \leq d_2$), or A takes the whole market (if $\pi_2' - \pi_2 > d_2$). $\square$

Proposition 4 shows that being the first mover can grant NA the chance to take all rational consumers rather than only group 2 consumers. Yet, even when NA is a first mover, with large enough addiction-generated ad revenue (a large $\pi_2' - \pi_2$), A takes the whole market, this time even regardless of the level of overall market segmentation $d_1 + d_2$. This highlights how an addictive platform can monopolize the market even as a second mover, with no incumbency advantage, by using its extra ad revenue enabled by addiction as leverage for exclusion. Note, though, that like the case when A moves first, market segmentation has a negative effect on investment in quality. In particular, rational consumers enjoy the largest quality level when market segmentation is low (part (ii)(a) of the Proposition).

Also, as when A moves first, it is easy to phrase the condition in part (i) of the Proposition in terms of network effects. NA is active if and only if they are very small (here, $\gamma \leq \frac{p[v(l)-v(h)]}{1-\alpha_2} - \frac{[\alpha_2 rp(h-l)]}{1-\alpha_2}$).

Consider now large network effects, of $\gamma \geqslant \widehat{\gamma}$. Here, by Lemma 1, for equal quality investment group 2 will choose the addictive platform, as will group 1. This means that now A has an advantage over NA with regard to both group 1 and group 2 consumers. Consequently, A will more often take the whole market. The results are summarized in the next proposition:

Proposition 5. *Suppose that there are more irrational than vulnerable consumers ($1 - \alpha \geq \alpha_2$) and network effects are large ($\gamma \geqslant \widehat{\gamma}$). In a sequential quality game:*

(i) If A moves first, it serves the whole market; If $\widehat{d}_1 - \widehat{d}_2 \geq \pi_1$, (where $\widehat{d}_1 \equiv \gamma(1-\alpha)$, $\widehat{d}_2 \equiv \gamma(1-\alpha_2) - p[v(l) - v(h)]$) A sets quality of $\pi_2 - \widehat{d}_2$ and if $\widehat{d}_1 - \widehat{d}_2 < \pi_1$ it sets quality of $\pi_1 + \pi_2 - \widehat{d}_1$.

(ii) If NA moves first, then:

(a) If $\pi_2' \geq \widehat{d}_1 - \widehat{d}_2$, A takes the whole market, setting quality $Q^a = 0$.

(b) If $\pi_2' < \widehat{d}_1 - \widehat{d}_2$, then when $\pi_2 > \widehat{d}_1$, NA takes the whole market, setting $Q^{na} = \widehat{d}_1 + \pi_1$,

while when $\pi_2 \leq \widehat{d}_1$, A takes the whole market, setting quality of zero.

Proof. $\widehat{d}_1 > \widehat{d}_2$ if and only if $\gamma < \frac{p[v(l)-v(h)]}{\alpha_1}$. Note that this is possible even though $\gamma \geqslant \widehat{\gamma}$ because $\frac{p[v(l)-v(h)]}{\alpha_1} > \frac{p[v(l)-v(h)]}{1-\alpha_2}$. To prove part (i), if $\widehat{d}_1 > \widehat{d}_2$ and A moves first and sets Q^a, NA's options are: (i) Remain inactive by setting $Q^{na} = 0$ and make zero profits; (ii) Serve only group 2 with $Q^{na} = Q^a + \widehat{d}_2$, making $\pi_2 - Q^a - \widehat{d}_2$; or (iii) Serve groups 1 and 2 with $Q^{na} = Q^a + \widehat{d}_1$, making $\pi_1 + \pi_2 - Q^a - \widehat{d}_1$. It prefers (iii) over (ii) if and only if $\pi_1 \geq \widehat{d}_1 - \widehat{d}_2$. If $\pi_1 \geq \widehat{d}_1 - \widehat{d}_2$, A can exclude NA from the market by setting $Q^a = \pi_1 + \pi_2 - \widehat{d}_1$, making $\pi_2' - \pi_2 + \widehat{d}_1 > 0$. Any smaller investment yields A zero profits from rational consumers. Suppose now that $\pi_1 < \widehat{d}_1 - \widehat{d}_2$. Here NA competes only over group 2, making $\pi_2 - Q^a - \widehat{d}_2$. A can exclude NA from doing this by setting $Q^a = \pi_2 - \widehat{d}_2$, making $\pi_2' - \pi_2 + \widehat{d}_2 > 0$, so it will do so and take the whole market. Suppose now that $\widehat{d}_1 \leq \widehat{d}_2$. Here, given Q^a, NA's only option is competing over both groups 1 and 2, by setting quality $\widehat{d}_1$ and making $\pi_1 + \pi_2 - Q^a - \widehat{d}_1$. But as before, A will exclude NA by setting $Q^a = \pi_1 + \pi_2 - \widehat{d}_1$ and making $\pi_2' - \pi_2 + \widehat{d}_1 > 0$. Note that quality is not necessarily higher for $\widehat{d}_1 - \widehat{d}_2 < \pi_1$, because $\pi_2 - \widehat{d}_2 > \pi_1 + \pi_2 - \widehat{d}_1$, implies $\widehat{d}_1 - \widehat{d}_2 > \pi_1$, in which quality is $\pi_2 - \widehat{d}_2$ while $\pi_2 - \widehat{d}_2 \leq \pi_1 + \pi_2 - \widehat{d}_1$ implies $\widehat{d}_1 - \widehat{d}_2 \leq \pi_1$, in which quality $\pi_1 + \pi_2 - \widehat{d}_1$ is provided.

To prove part (ii), suppose now that NA moves first. Consider first the case where $\widehat{d}_1 > \widehat{d}_2$. If $Q^{na} < \widehat{d}_2 < \widehat{d}_1$, A takes the whole market and NA makes zero profits. If $\widehat{d}_1 > Q^{na} > \widehat{d}_2$, A needs to set $Q^a = Q^{na} - \widehat{d}_2$ to retain group 2, making $\pi_2' - Q^{na} + \widehat{d}_2$ on group 2. To make positive profits, NA needs $Q^{na} = \pi_2' + \widehat{d}_2$. But it would then make $\pi_2 - \pi_2' - \widehat{d}_2 < 0$. NA's only remaining option is to set $Q^{na} \geq \widehat{d}_1 > \widehat{d}_2$. Then, A has two options: (i) Retaining only group 1 by setting $Q^a = Q^{na} - \widehat{d}_1$; or (ii) Monopolizing the market by setting $Q^a = Q^{na} - \widehat{d}_2$. Option (i) yields A a profit of $\pi_1 - Q^{na} + \widehat{d}_1$ while option (ii) yields $\pi_1 + \pi_2' - Q^{na} + \widehat{d}_2$. A prefers option (ii) over option (i) if and only if $\pi_2' \geq \widehat{d}_1 - \widehat{d}_2$. If $\pi_2' \geq \widehat{d}_1 - \widehat{d}_2$, then in order to make any profits NA needs to set $Q^{na} = \pi_1 + \pi_2' + \widehat{d}_2$. But then it would make $\pi_1 + \pi_2 - \pi_1 - \pi_2' - \widehat{d}_2 < 0$. Thus, NA sets $Q^{na} = 0$ and A takes the whole market with $Q^a = 0$. This proves part (ii)(a).

If $\pi'_2 < \widehat{d}_1 - \widehat{d}_2$, if at all, A prefers to retain only group 1, making $\pi_1 - Q^{na} + \widehat{d}_1$. Hence, if $Q^{na} > \pi_1 + \widehat{d}_1$, NA can take the whole market and make $\pi_1 + \pi_2 - \pi_1 - \widehat{d}_1$, which is positive if and only if $\pi_2 > \widehat{d}_1$. If $\pi_2 \leq \widehat{d}_1$, A can retain group 1. Group 2 is left to NA, which would make $\pi_2 - Q^{na} < \pi_2 - \widehat{d}_1 \leq 0$, where the first inequality follows because we assumed here that $Q^{na} > \widehat{d}_1$ and the second follows because we assumed $\pi_2 \leq \widehat{d}_1$. Accordingly, if $\pi_2 \leq \widehat{d}_1$, NA cannot compete over group 2 either, so it sets $Q^{na} = 0$ and A takes the whole market with $Q^a = 0$. This proves part (ii)(b). Now suppose $\widehat{d}_1 \leq \widehat{d}_2$. Here NA could attempt to take all rational consumers by offering $Q^{na} > \widehat{d}_1$, but A could prevent this by offering $Q^a = Q^{na} - \widehat{d}_1$, making $\pi_1 + \pi'_2 - Q^{na} + \widehat{d}_1$. In order to make any profit NA needs to set $Q^{na} = \pi_1 + \pi'_2 + \widehat{d}_1$, but then it would make $\pi_1 + \pi_2 - \pi_1 - \pi'_2 - \widehat{d}_1 < 0$, so $Q^{na} = 0$ and A takes the whole market with $Q^a = 0$. □

Proposition 5 implies that large network effects reduce segmentation, and increase the parameter regions in which the addictive platform captures the entire market. Note, though, than unlike in the case with small network effects, here competition over the whole market (brought about by low segmentation), does not involve more investment in quality. The large network effect allows the addictive platform to compete over the whole market even without investing in quality. Moreover, when NA moves first, for a large enough π_2, with large segmentation NA takes the whole market with positive investment in quality while with low segmentation, A takes the market with zero investment in quality..

4.2.2 More vulnerable consumers than irrational ones

When $1 - \alpha < \alpha_2$, with equal investment in quality, and with small network effects such that $\gamma < \widehat{\gamma}$, by Lemma 1 both groups 1 and 2 join the non-addictive platform. In particular, NA's advantage with regard to group 2 is $d'_2 \equiv p[v(l) - v(h)] - \gamma(1 - \alpha)$ while its advantage with regard to group 1 is $d'_1 \equiv \gamma[\alpha_2 - (1 - \alpha)]$. We plan to complete the analysis of this case in the next draft. For the time being, we wish to note that even in this extreme case, where all odds are in favor of the non-addictive platform, the addictive platform can still monopolize the market when addiction-generated ad revenue is large enough. The reason is that in order to compete with the addictive platform, the non-addictive platform needs to invest in quality matching this high ad revenue, and its own ad revenue is smaller, precisely because it is not addictive.

4.2.3 Platforms' choice of whether or not to be addictive

In this section we wish to ask whether the first mover in the sequential game prefers to be an addictive platform or not. We loosely consider here the case where there are more irrational than vulnerable consumers ($\alpha_2 < 1 - \alpha$) and network effects are small ($\gamma \leq \widehat{\gamma}$) and leave the other cases and a more rigorous analysis for future drafts. Consider the case where $d_1 + d_2 < \pi_1 + \pi_2' - \pi_2$, so that if the first mover is A and the second mover is NA, the first mover takes the whole market (Proposition 3), while $d_2 > \pi_2' - \pi_2$, so that if the first mover is NA and the second mover is A, the first mover is active. By Proposition 4, NA as such a first mover makes the same profit when it is active, whether it supplies all rational consumers or only group 2. We know from Proposition 4 that if $d_1 + d_2 \leq \pi_2'$, A as a second mover serves only irrational consumers.

Under such circumstances, if the first mover creates an addictive platform offering quality $Q_1 \geq \pi_1 + \pi_2 - d_1$, the second mover prefers being addictive, taking the whole market with quality $Q_1 + \varepsilon$. Being non-addictive yields zero profits, since by Proposition 3 the first mover as an addictive platform would take the whole market. Anticipating such Bertrand competition, if the first mover is addictive, it sets Q_1 to dissipate all of its profits. Hence, the first mover can do better by being non-addictive, setting $Q_1 = \overline{Q} \equiv \alpha rl - (1 - \alpha)rh$. Such a level of Q_1 makes the second mover indifferent between: a) being addictive, focusing only on irrational consumers, investing zero in quality and making $(1 - \alpha)rh$ (under the condition that $\overline{Q} \geq \pi_1 + \pi_2' - d_2$, so that an addictive second mover leaves rational consumers to the non-addictive platform), and b) being non-addictive, investing $\overline{Q} + \varepsilon$ in quality, taking all rational consumers, and earning αrl. The Pareto dominant equilibrium then is for the first mover to be non-addictive and the second to be addictive, dividing the market between them. This implies that competition could in certain circumstances help alleviate the distortion caused by addictive platforms.

This can change, however, if by Propositions 3 and 4 when A is the first mover, NA as a second mover gets group 2. Suppose also that $d_2 \leq \pi_2' - \pi_2 \leq d_1 + d_2 - \pi_1$. Here, if NA moves first and A moves second, NA earns zero. Under such circumstances, the first mover prefers to be addictive, setting quality making the second mover indifferent between being addictive and being non-addictive while taking group 2. This implies that even after endogenizing the decision whether to be addictive, there could be equilibria where the first mover decides to be addictive and exclude the second mover from supplying invulnerable consumers.

Consider now cases where NA is completely excluded even when it is the first mover. By Proposition 5, this occurs for $\pi_2' - \pi_2 \geq d_2$ when network effects are small and for $\pi_2' \geq \widehat{d}_1 - \widehat{d}_2$ when network effects are large. In such circumstances, the first mover is completely excluded if it decides to be non-addictive, so it prefers to be addictive. Under regulatory intervention preventing such monopolization of the market by the addictive platform as a second mover, things can improve if the intervention induces the first mover to be non-addictive. Such intervention, again, can take the form of a blunt prohibition from being addictive, or an antitrust rule (as noted, quite compatible with current antitrust doctrine) condemning the second mover's behavior as illegal monopolization. Since we have seen above that in some cases, competition can help alleviate addiction, antitrust rules, that are tailored to deal with the particular circumstances of each case, have an advantage over an across-the-board prohibition of addictiveness.

5 Extensions

In the next drafts of the paper (and before the conference), we intend to extend our analysis in the following directions: First, we plan to study the case of a continuum of consumers with different levels of self-control. We wish to explore whether in this framework too a first-mover can profitably exclude a second-mover by being addictive, and also whether even the second mover can exclude a non-addictive platform by being addictive. Second, we plan to combine the two modes of competition: over the level of addictiveness and over quality, to see how they interact with each other. Third, we wish to examine how the results are affected by other modes of competition, including competition over how much data the platform extracts from users or how much they expose users to ads, or when platforms can compete using subscription fees.

6 Conclusion

We have analyzed the implications of competition between an addictive platform and a non-addictive platform when the locus of competition is either the harm from addiction or investment in quality that is unrelated to addictive features. Our results indicate that when there is a group of consumers that are subject to addiction, but only some of them realize it, contestable markets are important for inducing control of that addiction when the locus of competition is on the level of addiction. The threat from a non-addictive platform will sometimes cause the addictive platform to moderate the risks from addiction in order to capture the entire market, particularly when network effects are sufficiently strong.

When the locus of competition is quality unrelated to addiction, an addictive platform can exclude a non-addictive platform when addiction-generated ad revenue is large enough. This can occur even in markets where a non-addictive platform enjoys all of the relevant advantages: being a first mover, low network effects, and a large group of vulnerable consumers. At the same time, when network effects are small, and market segmentation is low, although the addictive platform monopolizes the market, consumers benefit from more investment in quality than when market segmentation is high and the market is split between an addictive and a nonaddictive platform. When network effects are large, the addictive platform can monopolize the market even without high investments in quality.

Our findings imply that competition is not necessarily a fully effective remedy for the social loss stemming from addictive social media platforms, and that such competition requires government or court scrutiny, either by direct regulation of social media platforms' practices or by antitrust rules, in order to work properly. Otherwise, addictive platforms can utilize addictiongenerated ad revenue to exclude non-addictive platforms from the market in ways that can harm consumer welfare.

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