Group Hug: Platform Competition with User-groups*

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Abstract

We consider platform competition on small users and a user-group. One platform enjoys a quality advantage and the other benefits from favorable beliefs. We study whether the group mitigates the users' coordination problem – i.e., joining a low-quality platform because they believe that other users would do the same. We find that a group that can facilitate coordination on the high-quality platform may choose to maintain the dominance of the low-quality one. User's utility is non-monotonic in the proportion of the group. Finally, we highlight factors that motivate the group to help the high-quality platform to win the market.

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1 Introduction

Markets for platforms exhibit network effects where users benefit from joining the same platform other users join. This may create a coordination problem and inefficiencies where users join a low-quality platform, simply because they expect other users to do the same, and because each user is too small to affect the decisions of other users.

Yet, in many markets, some users join a platform as a group rather than joining individually. Platforms compete on small, individual users as well as on large users or user groups, where the latter may affect the former's decisions as to which platform to join. This raises the question of whether the presence of the group helps mitigate the coordination problem. Specifically, does the group choose the higher quality platform, when it anticipates that its choice would affect the choice of individual users? Moreover, how does the size of the group affect utility of users within and outside the group? Finally, what market characteristics enable user-groups to positively affect the market? For example, does allowing the group to multi-home help the market coordinate on the higher quality platform?

These questions are important for public policy with regards to the size of such large users. In particular, should antitrust authorities approve mergers between users that increase the users' concentration and provide a large user-group with market power to affect the identity of the dominant platform? In markets for platforms, mergers between users may have the welfare-enhancing effect of facilitating coordination on the right platform. At the same time, one must consider the welfare effects of a large user-group on users outside the group.

User-groups are common in many markets for platforms. For example, when launching iTunes, Steve Jobs first approached Warner Music, and other big labels, like Universal and Sony. Each of these big labels brought with it contracts with a large number of artists that joined the iTunes platform as a group.[1] Other examples include marketplace lenders who aim at attracting both private investors and large, institutional investors. These platforms, such as LendingClub and Prosper, have significantly evolved since the platforms' inception in late 2000s.[2] In the market for mobile operating systems, Apple and Google are competing on both small and large application developers. Similarly, in the mobile payment market, a large restaurant chain like McDonalds would likely make a collective decision for all its company-owned stores whether to join the Apple Pay

[1]See S. Knopper (2013).
[2]See P. Renton (2019).

platform, while small merchants, such as family-owned restaurants, make such decision individually.[3]

We study platform competition in a market with network effects with two types of users: a set of users that join the platform as a group and individual users. Platforms first compete over attracting the group and then on the individual users (platforms can charge individual users a different price than group-users). One of the platforms has a quality advantage while the other platform enjoys focality–meaning, users believe that it would be the dominant platform in the market.

We establish the following results. First, we find that even when the group is large enough to have the ability to facilitate coordination on the more efficient platform and thereby solve the coordination failure, the group may choose to maintain the dominance of the low-quality platform. More precisely, when the group is large enough, the platform that attracts the group also attracts the individual users. We say that such a group is *pivotal*. Yet, we find that a pivotal group that is not too large chooses to join the low-quality focal platform and thus drives the individual users to the low-quality platform as well. A case in point is the Beta vs VHS platform format where the Beta standard was considered to be of higher quality. Yet, VHS won the market. This is sometimes attributed to Matsushita's–one of the largest electronic manufacturers–commitment to adopt VHS. As Cusumano et al (1992) note, Sony's president acknowledged that he "made a "mistake" and should have worked harder to get more companies together in a 'family' to support the Beta-max format."

The intuition for this result is that the focal platform can extract the network effects that individual users gain from both group users and individual users. The non-focal platform can only extract the former value. Hence, when the proportion of the individual users is large enough, the focal platform can transfer this benefit to the group, making it more beneficial for the group to join the low-quality platform, on the expense of the individual users. When the group is relatively large, the value the focal platform can transfer to the group is not large enough to attract the group. In this case, the group joins the more efficient platform.

Our second main result is that a large group may not necessarily increase consumer surplus. Specifically, we find that the utility of an individual user is increasing and then decreasing with the proportion of the group. In total, an individual user prefers a small group over a large group, and prefers the most an intermediate group size. The utility

[3] See, e.g., Hospitality Technology (2014).

of a group user is also non-monotonic in the proportion of the group. If the group is large, an individual user that joins the group decreases the utility of each group user. Combining the utility of group and individual users, an increase in the size of the group has conflicting effects on total consumer surplus and the profits of the two platforms. Yet, at the point where the group switches from the low-quality to the high-quality platform, total welfare increases discontinuously with the proportion of the group.

Finally, we study factors that affect the group's ability to help the high-quality, non-focal platform win the market. First, when the group can multi-home, in equilibrium the group joins both platforms. Since individual users can meet the group on both platforms, the group's ability to affect their choice weakens which in turn makes it more difficult for the high-quality platform to win the market. This result contrasts the common belief that multi-homing is pro-competitive as it encourages exploration by consumers and thus helps new platforms enter the market. Indeed, in the case of the HD-DVD vs. Blu-ray format war, some believe that the decision by Warner Bros., who initially supported both formats, to stop issuing HD-DVD movies in early 2008 has helped Blu-ray win the market.[4]

A second factor is a group that can directly affect the beliefs of individual users and consequently the platforms' focal position. In this case, the group is more likely to choose the high-quality platform. Third, when the group joins a platform before individual users but the group cannot coordinate the decisions of its members, the group may join the low-quality platform regardless of its size. Finally, we comment on how the more horizontally differentiated the platforms, the weaker the group's effect on the individual users' decisions.

For policy, these results suggest that user mergers can indeed mitigate users' coordination problem. However, antitrust authorities should not adopt a too lenient approach towards user-merger for two reasons. First, a large user group may not facilitate coordination, even when it has the ability to do so. Second, a large user group can indirectly extract utility from individual users, through the subsidy offered by the platform, which in total can harm consumers. Qualitatively, intermediate sized user-groups seem to have positive effects on both individual and group users. Large user groups can be harmful, sometimes to both types of users.

[4]Blu-ray was considered to be of higher quality. For details on the history of studios' support, see M. Williams (2008).

Literature Review

Our paper contributes to the literature on platform competition with a coordination problem, where consumers need to form expectations concerning the decisions of other consumers. Katz and Shapiro (1986) study platform competition in a sequential game. They assume that consumers coordinate on the Pareto outcome and thus their model does not exhibit coordination failures. Caillaud and Jullien (2001; 2003) assume that an incumbent platform benefits from a focality advantage: if there is an equilibrium in which consumers join the incumbent's platform, then consumers play this equilibrium, even if there is a second equilibrium in which consumers join the entrant.[5] They show that platforms adopt a divide-and-conquer strategy in which they subsidize some consumers and charge a positive price from others.[6] Hagiu (2006) extends the focality approach to a sequential game. Jullien (2011) assumes a multi-sided market where one of the platforms offers a superior base quality. He finds that, when focality outweighs quality, a focal platform can dominate the market even when competing against a higher-quality platform. Hałaburda and Yehezkel (2013) consider focality advantage when users are ex-ante uninformed about their benefits from joining a platform, and become privately informed once they join. Hałaburda and Yehezkel (2016; 2019) extend the concept of focality to a partial degree of focality. In the context of a dynamic game, Hałaburda et al. (2020) consider a repeated game between a high and a low quality platform where the winning platform in the previous period becomes focal in the current period. Biglaiser and Crémer (forthcoming) consider dynamic platform competition on two groups of consumers that differ in their network effects.A common feature of all of these papers is that users are too small to affect the winning platform. Each user takes the focal position, and hence the decisions of other users, as given. We contribute to this literature by considering platform competition in a market with both a user-group (or a large user) and a set of small users.

Studying a related logic, Farrell and Saloner (1985) consider a sequential game where firms decide whether to switch to a new technology. A "bandwagon effect" emerges when some firms wait until a sufficient number of firms switch; thus, firms may all stay with the old technology. Their model does not consider platform competition and there is no asymmetry between large and small firms.

[5]In the terminology of Caillaud and Jullien, the incumbent benefits from "favorable beliefs": consumers expect other consumers to join it, whenever it is rational for them to do so.

[6]Segal (2003) studies the optimal divide-and-conquer pricing for a monopoly.

Several papers studied contingent pricing, when the contract to one set of consumers depends on the decisions of others. Dybvig and Spatt (1983), Segal (1999) and Winter (2004) consider a principal and agents in the presence of externalities, when the principal can contingent the contract to an agent (directly or indirectly) on the decisions of other agents. White and Weyl (2016) consider platform competition when the pricing to one side of the market depends on the participation of the other side. The pricing in our paper is somewhat related because platforms first compete on the group, and then compete on individual users. Yet, we assume that when platforms compete on the group, they cannot commit to their prices for individual users. Moreover, the group in our model internalizes its effect on the individual users' decision.

Several papers looked at platform competition with a large user.[7] Rochet and Tirole (2003) consider platform competition in a two-sided market, with a "marquee buyer": a large buyer that provides high network effects to the seller-side. They show that the presences of the marquee buyer raises the price the platform charges the seller-side. Their paper does not consider focality and the large buyer does not internalize its effect on other buyers' decisions, as in our paper. Akerlof et al. (2018) consider a market with network effects, allowing both for a focality advantage and product differentiation. In the context of a monopolistic platform, they show that an "influencer" buyer, that can affect the decisions of other buyers, can be in a pivotal position. We contribute to this paper by considering competition for the pivotal buyer, who internalizes the ability to affect the winning platform. Carroni et al. (2019) consider platform competition on small users and a "superstar", which provides higher network effects than the small users. Their paper focuses on horizontally differentiated platforms. Consequently, small users always benefit from the presence of a superstar. Our paper contributes to this idea by showing that when platform competition involves a coordination problem on a low-quality platform, a very large user may harm small users. Biglaiser et al. (2019) survey reasons for incumbency advantage in platform competition, and speculate that a pivotal buyer may be a mitigating factor on a platform's incumbency advantage. Our paper contributes to this idea by identifying how a pivotal buyer may, in fact, preserve the incumbency advantage of the low-quality platform.

[7] In our paper it is possible to interpret the group as a user that creates higher network effects than individual users. Sakovicz and Steiner (2012) analyze optimal subsidies for a monopolist when users differ in their externalities. Veiga et al. (2017) consider a monopolist where users have different valuation for quality and network effects. We contribute by considering platform competition and a strategic group that internalizes its effect on the wining platform.

Another strand of relevant literature concerns entry deterrence and naked exclusion. Rasmusen et al. (1991) and Segal and Whinston (2000) consider competition between an incumbent and a more efficient entrant that needs a sufficient scale in order to enter the market. This creates a buyers' coordination problem: when buyers expect other buyers to join the incumbent, the entrant cannot profitably enter the market. Karlinger and Motta (2012) study naked exclusion when buyers differ in size. When no individual buyer is large enough to provide the entrant with the scale needed for entry, there are exclusionary equilibria in which the inefficient incumbent dominates the market. Yet, in contrast to our finding, they find that in the context of naked exclusion, buyer-groups have pro-competitive effects.[8]

2 The model

Consider two platforms, platform A and platform B, and a mass 1 of identical users. The utility of a user from joining platform i ($i = A, B$) is $V_i(n_i) - p_i$, where p_i is the price of platform i and n_i is the number of users on platform i. $V_A(n)$ and $V_B(n)$ are two (different) continuous and twice differentiable functions with the following features:

Assumption 1: $V_i'(n) > 0$
Assumption 2: $V_B(n) > V_A(n), \forall n \in [0, 1]$
Assumption 3: $V_{A1} \equiv V_A(1) > V_{B0} \equiv V_B(0)$

Assumption 1 indicates that there are positive network effects: a user benefits the more other users join the same platform the user joins. For now, we allow for $V_i(n)$ to be concave or convex. Later on, we show that a sufficient condition for our main results is that $V_i(n)$ is not too concave. Assumption 2 means that given the same number of users on each platform, platform B offers higher value than platform A. This higher value can be due to superior base quality, such that $V_B'(n) = V_A'(n)$, and/or from platform's B superior ability to connect between users (i.e., $V_B'(n) > V_A'(n)$). Yet, by Assumption 3, a user prefers to join platform A when all other users are joining it, over joining an empty platform B. That is, network effects (meeting other members)

[8]The intuition behind the difference in results is that in the context of naked exclusion there are no direct network effects. Buyers' utility depends on the decisions of other buyers only through the effect of their decision on the identity of the winning platform. In contrast, under platform competition with network effects, users gain direct positive network effects as more users join the platform. This enables the focal platform to win the group and individual users even when the group is pivotal.

are more important to users than the quality gap between the two platforms. Finally, we normalize $V_A(0) = 0$.

Out of the mass of 1 users, a fraction x ($0 \leq x \leq 1$) belong to a user-group. The remaining users, $1 - x$, are "individual" users. One can interpret x as a group of small users that makes a collective decision, such as institutional investors in marketplace lending. Alternatively, x can measure the relative size of a large user, such as a large application developer in the market for mobile operating systems, or a potential merger between several small application developers.[9] In order to focus on the effect of users making a collective rather than an individual decision, we assume that the per-user value of joining a platform is the same for users in the user-group and individual users; i.e., $V_i(n)$.[10] Hence, the utility of the entire group from joining platform i is $xV(n_i) - p_i^G$, where p_i^G is the price that platform i charges the group. We assume that x is exogenous, that users (both the group and individual) can only join one platform (i.e., "single-home"),[11] and that the group cannot divide its members across the two platforms.

The timing of the model is as follows. In the first stage, the two platforms simultaneously set prices to the group, p_A^G and p_B^G , and the group chooses a platform. We allow p_A^G and p_B^G to be positive or negative and denote the group's decision by $J = \{A, B\}$. In the second stage, the two platforms compete by setting prices to the individual users, p_A and p_B. In the third stage, individual users observe J, p_A and p_B, and decide simultaneously and non-cooperatively which platform to join.

Our model makes the simplifying assumption that users (group and individual) are homogeneous. This assumption combined with the presence of network effects imply that in equilibrium all users join the same platform and the competing platform remains with no users. Intuitively, multiple platforms can co-exist when users differ in their subjective preferences over the competing platforms. In such markets, coordination problems and beliefs, which are the main focus of our paper, may not play a significant role. We comment on how our results are affected by the degree of product differentiation in Section 6. Moreover, Appendix C offers a simple example of horizontally differentiated platforms and shows that our main results hold though in equilibrium, both platforms gain positive market share.

[9] We measure the size of the group in proportional terms as we want to keep the overall network effects in the market unchanged. In Appendix B, we show that our main results hold for the case where the size of the group is absolute and not proportional.

[10] Members of the group may have higher utility than individual users. In order to focus on the net effect of the size of the group, we assume that the platforms offer identical value to both user types.

[11] We relax this assumption in Section 6.

As is typically the case when markets exhibit network effects, expectations play an important role. Consequently, given some values of J, p_A and p_B, the third stage may have two equilibria: one in which each individual user expects that all other users join A, in which case everyone joins A. In the second equilibrium, for the same values of J, p_A and p_B, all individual users join platform B, expecting that other users will do the same. Users play one of these equilibria, based on their beliefs concerning the platforms' ability to attract other users.

An incumbent platform, or a platform that dominated the market in the past, may benefit from favorable beliefs, as users may expect it to maintain its dominance and thus for other users to join it.[12] In order to model such beliefs advantage, in what follows, we follow Caillaud and Jullien (2001; 2003) by assuming that platform A is *focal*: whenever both outcomes are possible, individual users join platform A, expecting that other users will do the same. Users join platform B only if it is a dominant strategy for them to do so. Focality can emerge because of incumbency advantage or users' inertia. If platform A was the first to the market, users may expect that other users will continue to join the old platform, even though there are better, new alternatives. These beliefs can be rational, given that high network effects keep users on platform A.[13] We assume that the group cannot affect the beliefs of individual users. That is, platform A is focal for both $J = \{A, B\}$. We relax this assumption in subsection 6.2.

A benchmark case

To illustrate the inefficiency created by focality, consider a benchmark case in which all users are individuals: $x = 0$. In stage 3, when users decide which platform to join given p_A and p_B, there is an outcome in which all users join platform A if:

$$V_{A1} - p_A \geq V_{B0} - p_B \iff V_{A1} - V_{B0} \geq p_A - p_B. \tag{1}$$

Likewise, there is an outcome in which all users join platform B if

$$V_{B1} - p_B \geq V_{A0} - p_A \iff p_A - p_B \geq V_{A0} - V_{B1}. \tag{2}$$

[12]We focus on outcomes where all users join the same platform. All equilibria in which some join platform A while others join platform B are not stable. To see why, notice that in such an equilibrium all users have to be indifferent between joining A or B. Hence, if a user of mass ε switches from platform i to j, then now all users gain a higher utility in platform j than in i and all users will switch.

[13]For a review of the sources of focality, see Hałaburda and Yehezkel (2019).

Since $V_{A1} > V_{A0} = 0$ and $V_{B0} < V_{B1}$, $V_{A1} - V_{B0} > V_{A0} - V_{B1}$, implying that for $V_{A1} - V_{B0} > p_A - p_B > V_{A0} - V_{B1}$, both outcomes are possible. By the assumption that platform A is focal, users join A if $V_{A1} - p_A \geq V_{B0} - p_B$, and join platform B if $V_{A1} - p_A < V_{B0} - p_B$, expecting that others will do the same. Even though platform A is focal, platform B can still win the market, if equation (2) holds and equation (1) is violated. Notice that users' expectations concerning the equilibrium decisions of other users are realized. Yet, focality places a stronger criteria on the equilibrium in which the non-focal platform B wins. The focal platform A only needs to make sure that there is an equilibrium in which users join it. Platform B needs to make sure that there is no equilibrium in which users join A (to convince users that other users would not join platform A) and that there is an equilibrium in which users join B (to rational users' expectations that in equilibrium others join platform B).

When platform A is focal and $x = 0$, platform A always wins the market. To see why, platform A charges p_A such that equation (1) holds in equality, while the losing platform B charges the lowest price that ensures non-negative profits, $p_B = 0$. Substituting $p_B = 0$ in (1), platform A charges $p_A = V_{A1} - V_{B0} > 0$ and earns positive profit, where the inequality holds by Assumption 3. In a putative equilibrium in which the non-focal platform B wins, if such an equilibrium were to exist, platform B needs to charge p_B such that (1) holds in equality given $p_A = 0$, but then $p_B = -(V_{A1} - V_{B0}) < 0$, again from Assumption 3, implying that platform B cannot profitably win the market.

That is, with no group, the inefficient, focal platform always wins the market. Intuitively, focality means that platform A can collect the users' network effects because users expect that other users join A. Platform B can only collect its quality advantage. Yet, network effects are more important to users than the quality advantage, by Assumption 3, resulting in an equilibrium in which platform A wins. That is, the inability of users to coordinate their choices creates a mis-coordination in which they all join the inefficient platform. This raises the question: when and how can a user-group correct this market failure? In what follows, suppose that $x > 0$.

3 Competition on the individual

We start by solving the second and third stages: platform competition on the individual users, given that the group already joined a platform. We establish the preliminary result that a large group is pivotal–i.e., can determine which platform wins the individual users. This will be important in the next section, for our main result that a pivotal group may join platform A. We study the two cases where the group joins platform A and platform B in turn.

Suppose first that $J = A$. As individual users know that x users joined platform A, and they also expect that the remaining $1 - x$ individual users join platform A, the outcome is the same as in our benchmark case. Lemma 1 below shows that when $J = A$, platform A charges the same price as in the benchmark case, $p_A = V_{A1} - V_{B0}$, and wins the individual users. Denoting platform i's profits from the individual users given x and the decision of the group, J, by $\pi_i(x; J) \equiv p_i(1 - x)$, platform A earns $\pi_A(x; A) = (1 - x)(V_{A1} - V_{B0}) > 0$.

Suppose now that the group joins platform B. In an equilibrium where platform A wins the individual users, platform B charges the lowest price that ensures non-negative profits, $p_B = 0$, and platform A attracts the individual users by charging:

$$V_A(1 - x) - p_A \geq V_B(x) - p_B, \quad p_B = 0 \quad \Longrightarrow \quad p_A = V_A(1 - x) - V_B(x). \tag{3}$$

The equilibrium requires that platform A earns positive profit from the individual users: $\pi_A(x; B) = (1-x)p_A > 0$, where using (3): $\pi_A(x; B) = (1-x)(V_A(1 - x) - V_B(x))$. Likewise, Lemma 1 below shows that in an equilibrium in which platform B wins the individual users, $\pi_B(x; B) = -\pi_A(x; B)$. Hence, platform A wins the individual users iff $V_A(1 - x) \geq V_B(x)$. Let $\widehat{x}$ denote the solution to:

$$V_A(1 - \widehat{x}) = V_B(\widehat{x}). \tag{4}$$

The following lemma summarizes the second stage (all proofs are in the appendix):

Lemma 1. ***(The group may be pivotal)*** *When $J = A$, there is a unique equilibrium where platform A always wins the individual users, sets $p_A(x; A) = V_{A1} - V_{B0}$ and earns from them $\pi_A(x; A) = (1 - x)(V_{A1} - V_{B0})$.*

When $J = B$, there is a threshold, $\widehat{x}$, where $\widehat{x}$ is the solution to $V_A(1 - \widehat{x}) = V_B(\widehat{x})$, and $0 < \widehat{x} < \frac{1}{2}$ such that:

(i) when $x \in [0, \widehat{x}]$, platform A wins the individual users, sets $p_A(x; B) = V_A(1-x) - V_B(x)$ and earns from them: $\pi_A(x; B) = (1 - x)(V_A(1 - x) - V_B(x))$;

(ii) when $x \in [\widehat{x}, 1]$, platform B wins the individual users, charges $p_B(x; B) = V_B(x) - V_A(1 - x)$ and earns from them: $\pi_B(x; B) = (1 - x)(V_B(x) - V_A(1 - x))$.

Lemma 1 shows that if the group is small, $x < \widehat{x}$, platform A always wins the individual users due to its focal position, regardless of whether the group joins it or not. Once the group is sufficiently large, it becomes *pivotal* in the sense that the group determines the platform that wins the entire market. By choosing to join the more efficient non-focal platform B, the group provides platform B with large enough network effects to win the individual users. The result that, depending on its size, the group has the ability to solve the inefficiency created by platform A's focality raises the question: under what market conditions the group makes the efficient choice and joins the higher quality platform. We study this below.

4 Competition on the group

Consider now the first stage, where platforms compete on attracting the group. The group joins the platform that provides it with the highest benefit as a group, $xV_i(n_i)-p_i^G$ (recall that p_i^G is the price for the entire group). Hence, when making a decision, the group takes into account the platforms' qualities, prices, and how the group's decision affect the individuals' decision. The latter case depends on whether the group is smaller or larger than $\widehat{x}$. The main results of this section is that even when the group is pivotal and hence can help the high quality platform win the market, the group may prefer to preserve platform A's dominant position.

As expected, when the group is small and not pivotal, platform A wins the entire market. Since we are interested in the case where the group mitigates the inefficiency created by platform A's focality, we start our analysis with the case where the group is pivotal and then move to a non-pivotal group.

4.1 When does the group choose the efficient outcome?

Suppose that the group is large enough to determine the winning platform: $x \geq \widehat{x}$. In this case, the group gains a utility of $xV_{i1} - p_i^G$ from joining platform i.

Consider an equilibrium in which platform A wins the group (and consequently the individual users). The lowest price that platform B is willing to charge the group is its profit from winning the individuals. Platform A charges the highest price possible that induces the group to join it, given that the individual users will follow. Hence:

$$xV_{A1} - p_A^G \geq xV_{B1} - p_B^G, \quad p_B^G = -\pi_B(x; B). \tag{5}$$

Notice that the group gains a higher gross utility from joining platform B: $xV_{B1} > xV_{A1}$. However, the group would join platform A if platform A sets a sufficiently low price. Substituting $\pi_B(x; B)$ from Lemma 1 into (5),

$$p_A^G = -(1-x)\left(V_B(x) - V_A(1-x)\right) - x\left(V_{B1} - V_{A1}\right). \tag{6}$$

Note that both platforms set negative prices for the group. The logic is similar to the "divide-and-conquer" strategy (Caillaud and Jullien (2003)), where platforms compete in subsidizing one set of users in order to attract another set. Here, platforms compete on attracting the group because the group determines which platform wins the individual users.[14]

In an equilibrium in which platform A wins the market, it must be that platform A earns positive total profit. Let $\Pi_i(x; i) \equiv \pi_i(x; i) + p_i^G$ denote the total profit of platform i when it wins the group and individual users. Substituting $\pi_A(x; A)$ from Lemma 1 and (6) into $\Pi_A(x; A) = \pi_A(x; A) + p_A^G$,

$$\Pi_A(x; A) = (V_{A1} - V_{B0}) - x\left(V_{B1} - V_{B0}\right) - (1-x)\left(V_B(x) - V_A(1-x)\right). \tag{7}$$

Using similar logic, the equilibrium in which platform B wins the group and the individuals satisfies $p_A^G = -\pi_A(x; A)$ and $xV_{A1} - p_A^G = xV_{B1} - p_B^G$, hence:

$$p_B^G = x\left(V_{B1} - V_{B0}\right) - \left(V_{A1} - V_{B0}\right). \tag{8}$$

Notice that while $p_A^G < 0$, p_B^G can be negative (if x is close to $\widehat{x}$) or positive (if x is sufficiently close to 1). Intuitively, once the group's proportion is close to 1, the superior utility that platform B offers the group, xV_{B1}, is sufficiently high to enable platform B to attract the group with a *positive* price, even though platform A charges the group a negative price. An equilibrium in which platform B wins the market exists if $\Pi_B(x; B) = \pi_B(x; B) + p_B^G > 0$. Substituting $\pi_B(x; B)$ from Lemma 1 and (8) into $\Pi_B(x; B) = \pi_B(x; B) + p_B^G$, and rearranging the terms we get that $\Pi_B(x; B) = -\Pi_A(x; A)$. Hence, if (7) is positive, there is a unique equilibrium in which platform A wins the group and the individual users. Otherwise, there is a unique equilibrium

[14] This timing has the flavor of a two-sided market, when the group users are the first side and individual users are the second side. Yet, in our model the first side makes a collective decision and internalizes the effect its decision has on the platform's ability to attract the other side. In subsection 6.3, we compare our results with the case where the group is uncoordinated.

in which platform B wins. Using the definition of $\Pi_A(x; A)$ in (7), let $\widetilde{x}$ denote the solution to: $\Pi_A(\widetilde{x}; A) = 0$. We, therefore, have the following proposition:

Proposition 1. ***(A pivotal group may join platform** A**)*** *Suppose that* $x > \widehat{x}$*, then*

(i) *When* x *is slightly higher than* $\widehat{x}$*, there is a unique equilibrium in which platform* A *wins the group, if the (sufficient) conditions that* $V_A(n)$ *is convex or linear in* n *and* $V_{B1} - V_{B0} \leq V_{A1}$ *hold.*

(ii) *When* x *is close to* 1*, there is a unique equilibrium in which platform* B *wins the group.*

(iii) *When* $\pi_B(x; B)$ *is concave in the proportion of the individual users:*

$$-2\left(V_B'(x) + V_A'(1-x)\right) + (1-x)\left(V_B''(x) - V_A''(1-x)\right) < 0. \tag{9}$$

then, there is a unique cutoff, $\widehat{x} < \widetilde{x} < 1$*, such that platform* A *wins the group if* $x < \widetilde{x}$ *and platform* B *wins when* $x > \widetilde{x}$*.*

Proposition 1 shows that when the group is large enough to determine the identity of the winning platform, but not too large, the outcome may be inefficient as the group may choose to adopt the low-quality platform, A. The market ends up with the efficient outcome only when the group is substantially large, in which case it chooses the high-quality platform B.

The intuition behind this result is represented by the following equation, which results from rearranging terms in $\Pi_A(\widetilde{x}; A) = 0$ (using equation (7)):

$$\underbrace{(1-x)(V_{A1} - V_{B0})}_{A\text{'s gain from individuals}} + \underbrace{xV_{A1}}_{\text{Group's gain: } A} \geq \underbrace{(1-x)(V_B(x) - V_A(1-x))}_{B\text{'s gain from individuals}} + \underbrace{xV_{B1}}_{\text{Group's gain: } B} \tag{10}$$

The left hand side in (10) represents the value to platform A from winning the group–the network effect platform A extracts from the individual users–and the value the group gains from adopting platform A. Together these represent the joint value for the platform and the group, if platform A wins the market. Similarly, the right hand side represents the joint value to the platform and the group, if B wins. Equation (10) then implies that for a platform to win the market, it must be the case that the joint value on that platform is higher than the joint value on the competing one. The group's base utility is always higher when the group joins platform B: $xV_{B1} > xV_{A1}$. Still, platform

A may gain more from the individual users as its focal position enables it to collect the utility of each individual user from meeting other individual users as well as from meeting group users. In contrast, the non-focality of platform B implies that it can only collect the individual's utility from meeting the group. By joining platform A, the pivotal group drives individual users to join platform A as well. Platform A can then collect their network effects and share this value with the group by offering the group a larger subsidy: $-p_A^G > -p_B^G$.[15]

The intuition for the conditions in Proposition 1 are the following. First, when the proportion of individual users is large enough (i.e., x is close to $\widehat{x}$), the focality advantage of platform A dominates platform B's superior quality and A can attract the group. If, however, the proportion of the individuals is small, platform A cannot extract enough network effects to compensate the group for the lower quality platform A offers and platform B wins the group.

The intuition for the convexity of $V_A(x)$ as a sufficient (though not necessary) condition is the following. Recall that the group chooses focal platform A due to the platform's ability to extract the network effects the individual users generate. These network effects become larger as $V_A(x)$ is more convex. To see why, Figure 1 illustrates the case of a linear and a convex $V_A(x)$. It is possible to see that, given the same group size and total network effects, the more convex $V_A(x)$, the larger the individual users' contribution and the smaller the group's contribution to the total network effects. This effect provides platform A with a larger value to extract from the individual users that enables it to win the group. The importance of the sufficient (again, not necessary) condition $V_{B1} - V_{B0} \leq V_{A1}$ has similar intuition. This condition implies that total network effect on platform A, $V_{A1} - V_A(0)$ (recall that we set $V_A(0) = 0$), should not be much lower than the the total network effects on platform B, $V_{B1} - B_{B0}$. Otherwise, platform A's advantage, may be too small for it to win the group.

The last part of Proposition 1 shows that when platform B's revenue function from serving the individuals (given $J = B$) has the standard concavity feature, the model has a unique cutoff in the size of group (or individual) users such that platform A wins the group if the size of the group (individual) is smaller (larger) than this cutoff.[16]

[15] It is straightforward to see that if platforms are not strategic (i.e., set zero prices for both group and individual users), equation (10) reduces to $xV_{A1} > xV_{B1}$, in which case a pivotal group always makes the efficient decision and joins the high-quality platform.

[16] The first term in (9) is negative because $V_i'(n) > 0$. Thus, (9) always holds when $V_i(n)$ are linear and also when $V_A(n)$ ($V_B(n)$) is convex (concave), or not too concave (convex). For example, condition (9) holds when $V_A(n) = \lambda n^\alpha$ and $V_B(n) = Q + \lambda n^\alpha$, at least when $0 < Q < \lambda < 1$ and $0 < \alpha \leq 2$.

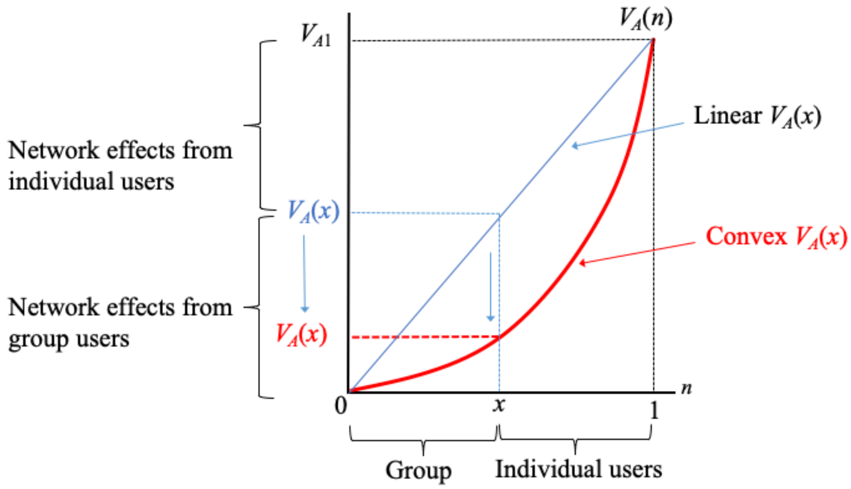


Figure 1: Linear and convex $V_A(n)$

Note that equations (10) and (9) imply that the threshold $\widetilde{x}$ does not depend on whether the group or the platform have the bargaining power in the negotiation. That is, just like the Nash bargaining outcome, $\widetilde{x}$ is determined by the joint value of the group and the platform and bargaining would only affect the share each party can capture.

Corollary 1. ***($\widetilde{x}$ does not depend on who announces prices)*** *The minimum group size needed for the group to choose the efficient outcome, $\widetilde{x}$, does not depend on whether platforms announce prices to the group, or the group announces offers to the platforms.*

For completeness, we conclude this subsection with the simple case where the group is not pivotal, i.e., when $x < \widehat{x}$. The group does not create large enough network effects and thus cannot help platform B win the individual users. Furthermore, the group knows that it can meet the individual users only on platform A. Since the group is relatively small, the network effects the group members create for each other on platform B are not large enough for the group to prefer it. Consequently, the group is better off joining platform A. Proposition 2 below shows that in this case, platform A always wins the group.

Proposition 2. ***(When not pivotal, the group always chooses the inefficient platform)*** *Suppose that $x < \widehat{x}$. Then, there is a unique equilibrium in which platform A wins the group and the individual users. Platform A charges the group and individual users: $p_A = V_{A1} - V_{B0}$ and $p_A^G = x\,(V_{A1} - V_B(x))$, respectively, and earns $\Pi_A(x; A) = V_{A1} - (1-x)V_{B0} - xV_B(x)$ while platform B earns 0.*

In what follows, we assume that the conditions in Proposition 1 hold. To conclude this section, we find that for $x \in [\widehat{x}, \widetilde{x})$, the group is pivotal, yet, joins platform A. When $x \in [\widetilde{x}, 1]$, the group is still pivotal and chooses platform B. For $x \in [0, \widehat{x}]$, the group cannot affect the winning platform and platform A wins.

4.2 Example

To illustrate the main results of this section, suppose in this subsection that $V_A(n) = \lambda n$ and $V_B(n) = Q + \lambda n$.The parameter λ represents the network effect and Q the relative quality advantage platform B offers. We assume that $0 < Q < \lambda$ such that Assumptions $1 - 3$ hold.

Given this functional form, $\widehat{x} = \frac{1}{2} - \frac{Q}{2\lambda}$ and $\widetilde{x} = 1 - \frac{1}{4\lambda}\left(Q + \sqrt{(8\lambda + Q)Q}\right)$. Figure 2 illustrates the thresholds $\widehat{x}$ and $\widetilde{x}$ as a function of the quality gap between the two platforms, adjusted by the level of network effects (i.e., Q/λ). The figure shows that as the quality gap between the platforms increases, the range within which the group is pivotal yet chooses the inefficient platform, $[\widehat{x}, \widetilde{x})$, becomes smaller and the range of group ratios that result in an efficient choice of platform B increases. In particular, starting at $Q/\lambda \to 0$, we have that $\widehat{x} \to \frac{1}{2}$ and $\widetilde{x} \to 1$. Due to either the low quality-gap or high network effects, a pivotal group almost always chooses the inefficient platform. As Q/λ increases, both $\widehat{x}$ and $\widetilde{x}$ decrease and so does the gap $[\widehat{x}, \widetilde{x})$. Only in the extreme case of $Q/\lambda \to 1$, the pivotal group always chooses the high-quality platform.

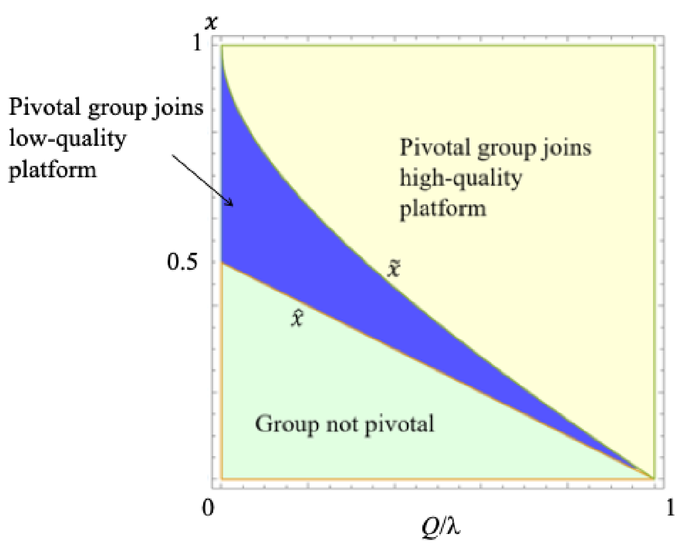


Figure 2: $\widehat{x}$ and $\widetilde{x}$ as a function of Q/λ

The analysis above looks at a proportional increase in the group while keeping the total number of users constant. This assumption corresponds to the case where individual users switch to (or merge to) a group; as opposed to new users entering the market and joining the group. In Appendix B, we show that the qualitative results of Figure 2 follows to an increase in the absolute size of the group when the number of individual users remains unchanged. As in Figure 2, we find that the interval of x in which the pivotal group joins platform B, $[\widehat{x}, \widetilde{x})$, decreases with Q/λ. Moreover, the appendix shows that an increase in the absolute number of individual users increases $\widehat{x}$ and $\widetilde{x}$ and expands the range $[\widehat{x}, \widetilde{x})$. The intuition for this result is that as the absolute size of individual users increases, the group becomes proportionally smaller and its ability to affect the winning platform decreases.

5 The effect of the proportion of the group on profits and users' surplus

This section studies how an increase in the proportion of the group, x (i.e., when an individual user joins the group or a user-merger), affects the platforms' profits and users' utility. The main conclusion of this section is that a proportionally large group may not always be beneficial to users. In particular, the utilities of both an individual and a group user are non-monotonic in the proportion of the group. That is, when individual users join the group, they may hurt the remaining individual users as well as group users. This effect is mainly due to the decrease in the proportion of individual users. An absolute increase in the size of the group (e.g., new users enter the market and join the group) always have a positive effect on total consumer surplus.

The next subsection studies the effect of an increase in x on an individual user. We then look at the effect of x on a group user. Finally, we show how x affects total consumer surplus and firms' profits.

5.1 The effect of the proportion of the group on an individual user

The utility of each individual user is $u(x) = V_{A1} - p_A(x; A)$ if A wins the market, and $u(x) = V_{B1} - p_B(x; B)$ if B wins, where $p_A(x; A)$ and $p_B(x; B)$ are given by Lemma 1. Putting this together, we get the following utility function for an individual user:

$$u(x) = \begin{cases} V_{B0}, & \textit{if } x \in [0, \widetilde{x}), \\ V_{B1} - \left(V_B(x) - V_A(1-x)\right), & \textit{if } x \in [\widetilde{x}, 1]. \end{cases} \tag{11}$$

The following proposition summarizes how x affects the utility of an individual user:

Proposition 3. ***(The effect of the group size on an individual user)***

(*i*) *When* $x \in [0, \widetilde{x})$*, changes in the proportion of the group do not affect the utility of an individual user*

(*ii*) *At* $x = \widetilde{x}$*, there is a discontinuous climb in the utility of an individual user*

(*iii*) *When* $x \in (\widetilde{x}, 1]$*, the utility of an individual user decreases with the proportion of the group and equals* 0 *at* $x = 1$*.*

Figure 3 illustrates the general results in Proposition 3 using the example in subsection 4.2. As Proposition 3 shows, the utility is non-monotonic. Specifically, when the group joins platform A, the proportion of the group does not affect the utility of an individual user. Since individual users believe that platform A is focal, A can extract the network effects they generate to each other. Consequently, the individual users are agnostic to whether users join platform A individually or as part of the group. This is not the case when platform B wins the market. When the size of the group reaches $\widetilde{x}$, there is a discontinuous climb in the utility of an individual user for two reasons. First, the user gets to enjoy the superior quality. Second, platform B is non-focal and therefore cannot extract the network effects that the individual users generate to each other. As the proportion of the group increases further above $\widetilde{x}$, the proportion of individual users becomes negligible and the second effect becomes weaker – decreasing their utility. Finally, the last marginal user that is still outside the group (when $x \to 1$) earns 0. Notice that this implies that an individual user may prefer a small group that joins the "wrong" platform A, over a large group that helps the high-quality platform win the market. Moreover, the optimal group size from the viewpoint of an individual user is of intermediate level: $\widetilde{x}$.

The analysis above looks at a proportional increase in the size of the group: i.e., individual users join or merge into a group. Such an increase may hurt the remaining individual users, because of the resulting decrease in the size of the individual users. In Appendix B, we analyze the case where the size of the individual users is independent of the size of the group. This allows us to disentangle the effect of an increase in the size of the group from the effect of a decrease in the size of the individual users. We show that an increase in the absolute size of the group may either increase (when x crosses the threshold $\widetilde{x}$) or not change the utility of individual users. Consistent with the intuition above, a decrease in the size of individual users decreases the utility of an individual user.

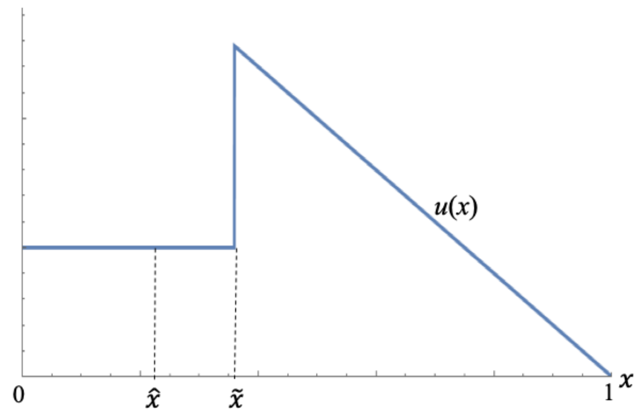


Figure 3: individual users' utility as a function of x (when $\frac{Q}{\lambda} = 0.5$)

5.2 The effect of the proportion of the group on a single group user

The utility of a single group user is $u^G(x) = V_{A1} - \frac{p_A^G}{x}$ if A wins the market, and $u^G(x) = V_{B1} - \frac{p_B^G}{x}$ if B wins, where p_A^G is given by Proposition 2 when $x \in [0, \widehat{x})$, (6) when $x \in [\widehat{x}, \widetilde{x}]$, and p_B^G is given by (8). Hence,

$$u^G(x) = \begin{cases} V_B(x), & \textit{if } x \in [0, \widehat{x}), \\ V_{B1} + \frac{(1-x)(V_B(x) - V_A(1-x))}{x}, & \textit{if } x \in [\widehat{x}, \widetilde{x}), \\ V_{B0} + \frac{V_{A1} - V_{B0}}{x}, & \textit{if } x \in [\widetilde{x}, 1]. \end{cases} \tag{12}$$

Proposition 4 characterizes the effect of x on the utility of a single group user:

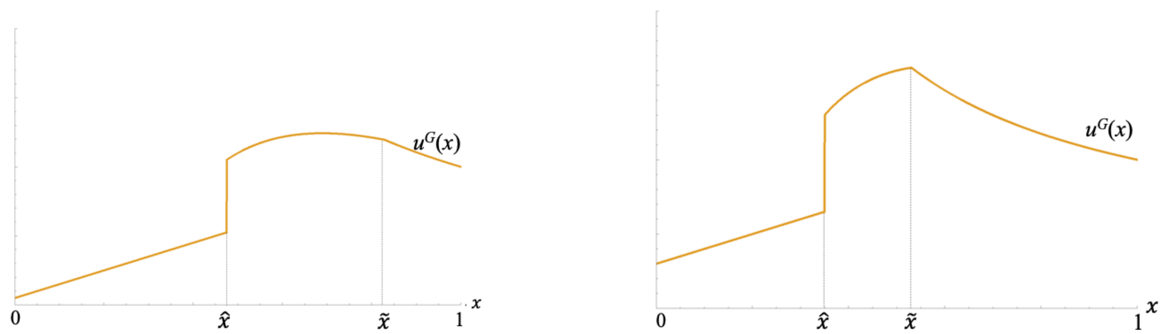
Proposition 4. ***(The effect of the group size on a single group user)***

(*i*) *When $x \in [0, \widehat{x}]$, the utility of a single group user is increasing in x, with a discontinuous jump at $x = \widehat{x}$.*

(*ii*) *Evaluated at x slightly above $\widehat{x}$, the utility of a group user is increasing in x. Further increases in x at the interval $x \in [\widehat{x}, \widetilde{x}]$ has an ambiguous effect on the utility of a group user.*

(*iii*) *When $x \in [\widetilde{x}, 1]$, the utility of a group user is decreasing in x.*

Again, we illustrate the general results using the example in subsection 4.2 (Figure 4). Proposition 4 shows that the utility of a group user increases with the proportion of the group when $x \leq \widehat{x}$, with a discontinuous climb at $x = \widehat{x}$. Intuitively, as the group becomes larger, the utility from its alternative option of joining platform B increases, forcing platform A to offer the group better terms. At $x = \widehat{x}$, the group becomes pivotal which triggers more intense competition between the two platforms, increasing the group's surplus. A further increase in x has two conflicting effects on $u^G(x)$. First, the group's alternative option increases with its size. At the same time, the decrease in the proportion of individual users reduces the platforms' strategic benefits from attracting the pivotal group (notice that this effect is insignificant when the group is not pivotal). For the general utility function we can only infer that $u^G(x)$ increases with x at $x = \widehat{x}$. Using the example in subsection 4.2, we find that when $x \in [\widehat{x}, \widetilde{x}]$, $u^G(x)$ is an inverse U-shape of x if $Q < \lambda(3\sqrt{3} - 5) \cong 0.196\lambda$, and strictly increasing otherwise. We illustrate these two options in panels (a) and (b) of Figure 4.



Panel (a): small Q ($\frac{Q}{\lambda} = 0.05$) Panel (b): large Q ($\frac{Q}{\lambda} = 0.3$)

Figure 4: Group users' utility as a function of the size of the group

Proposition 4 also reveals that when $x \in [\widetilde{x}, 1]$, group users are hurt when an individual user joins the group. In this range, the group wants platform B for its superior quality while platform B needs the group for its pivotal position. As x increases, the first effect becomes stronger and the second effect becomes weaker–decreasing the value the group can extract from platform B.

Our focus on a proportional change in the size of the group enables us to study whether users inside the group benefit when individual users outside the group join it and thereby decrease the size of the individual users. The results indicate that a group user benefits from an increase in the proportion of the group when the group is at least pivotal, i.e., $x > \widehat{x}$. Yet, beyond $\widetilde{x}$, additional users that join the group in fact harm existing group members. This is due to the negative effect of a decrease in the size of individual users. In Appendix B we disentangle this negative effect. We find that for $x \leq \widetilde{x}$, the utility of a group user always increases with the absolute size of the group. For x slightly above $\widetilde{x}$, an increase in the size of the group may decrease the utility of a group user (when the size of individual users is small) or increase it. A further increase in the size of the group always increases the utility of each group member.

5.3 The effect of the proportion of the group on total profits and total users' surplus

In this subsection we evaluate the effect of the proportion of the group on total profits, consumer surplus and welfare. Recall that when $x \in [0, \widehat{x})$, platform A wins the market and earns $\Pi_A(x; A)$ as given by (18), while when $x \in [\widehat{x}, \widetilde{x})$ $(x \in [\widetilde{x}, 1])$, platform A (B) wins and earns $\Pi_A(x; A)$ $(\Pi_B(x; B) = -\Pi_A(x; A))$, respectively, where $\Pi_A(x; A)$ is given by (7). Therefore, total profit as a function of x is:

$$\Pi(x) = \begin{cases} V_{A1} - (1-x)V_{B0} - xV_B(x), & \text{if } x \in [0, \widehat{x}), \\ (V_{A1} - V_{B0}) - x\,(V_{B1} - V_{B0}) - (1-x)\,(V_B(x) - V_A(1-x))\,, & \text{if } x \in [\widehat{x}, \widetilde{x}), \\ x\,(V_{B1} - V_{B0}) + (1-x)\,(V_B(x) - V_A(1-x)) - (V_{A1} - V_{B0})\,, & \text{if } x \in [\widetilde{x}, 1]. \end{cases}$$

Let $W(x) = V_{i1}$ denote total welfare as a function of x given that platform $i = \{A, B\}$ wins (notice that i is a function of x). The users' surplus – total users' utility given the winning platform i – is $CS(x) = V_{i1} - \Pi(x)$. The following proposition describes how x affects $\Pi(x)$ and $CS(x)$:

Proposition 5. ***(A large group may harm users)***

(*i*) *When $x \in [0, \widetilde{x})$, $\Pi(x)$ is decreasing with x, with a discontinuous drop at $x = \widehat{x}$. When $x \in [\widetilde{x}, 1]$, $\Pi(x)$ is an inverse U-shape function of x.*

(*ii*) *When $x \in [0, \widetilde{x})$, $CS(x)$ is increasing with x, with discontinuous climbs at $x = \widehat{x}$ and $x = \widetilde{x}$. When $x \in [\widetilde{x}, 1]$, $CS(x)$ is a U-shape function of x. Moreover, when x is close to 1, $CS(x)$ is lower than $CS(x)$ when x is slightly higher than $\widetilde{x}$.*

Figure 5 illustrates the results in Proposition 5. The bold line represents $CS(x)$, the double line represents $W(x)$, and $\Pi(x)$ is the gap between the two (yellow area).[17] The figure shows that an increase in x is not always beneficial to users. For $x \in [0, \widetilde{x})$, users' surplus is increasing in x and jumps at $x = \widetilde{x}$ where it reaches its maximal level.

[17]The first part of $CS(x)$ (when $x \in [0, \widehat{x})$) is convex (concave) in x when $2V'_B(x) + xV''_B(x) > 0$ $(2V'_B(x) + xV''_B(x) < 0)$.

Recall that for these group sizes, the utility of both individual and group users is either increasing in x, or, increasing (individual users) and slightly decreasing (group users). Then, for $x > \widetilde{x}$, users' surplus first decreases with x because the decrease in both group and individual users' utilities. Then, when the "last" individual users join the group, they gain an increase in their own utilities, which is larger than the decrease in the utilities of group members. This last result implies that users may be better off under the inefficient outcome where the group chooses to join the low-quality platform as compared to the efficient case where the group chooses the high-quality platform.[18] The size of the group affects the platforms' profits in opposite directions. Platform A's profit is always decreasing with x, while platform B's profit is first increasing and then decreasing with x.

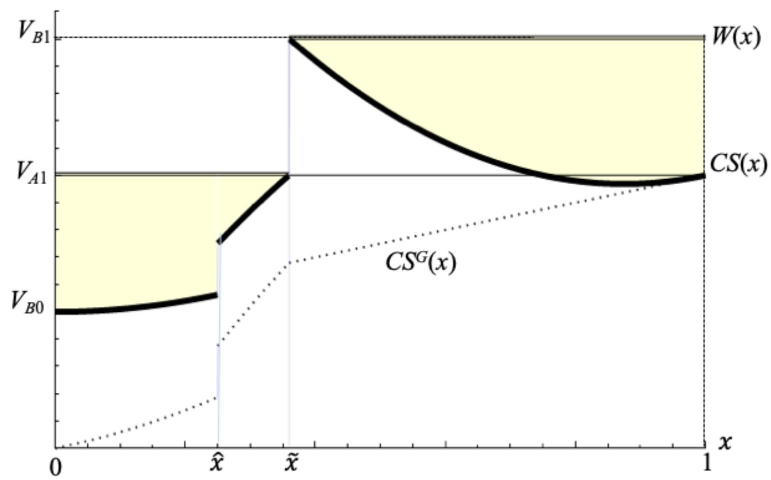


Figure 5: Consumer surplus and welfare as a function of x ($\frac{Q}{\lambda} = 0.5$)

6 Factors affecting the group's incentives to choose the efficient outcome

In this section we relax some of the model's assumptions to study their effect on the group's incentives to choose the efficient platform B. We first look at the case where the group can multi-home. We then relax the exogenous focality assumption and study the case where the group can affect the individual users' beliefs about the focal platform.

[18] In the case of an absolute increase in the size of the group, Appendix B shows that consumer surplus is always increasing with the size of the group and may increase or decrease with the absolute size of individual users.

We move to the case where the group's choice is not cooperative, yet the group still makes its platform choice before the individual users. This allows us to disentangle the effect of a cooperative decision from the effect the sequential decision making has on our main results. Finally, we comment on how horizontal product differentiation affects the group's incentive to join the focal platform A.

6.1 Multi-homing

In many of the examples we introduced above users multi-home–i.e., choose to be affiliated with more than one platform. For example, McDonalds accepts Apple Pay and Google Pay, and EA Sports' games are compatible both with the iOS and Android mobile operating systems. In this section, we account for the possibility of multi-homing and examine whether multi-homing helps mitigate the coordination failure. Since we are interested in the effect on coordination failures, we look at the case where the group can multi-home while the individual users single home.

We start with the last stage: competition on individual users. Since Section 3 studies the case where the group single homes, we need only to analyze the individual users' choice when the group chooses to multi-home.

Lemma 2. ***(The effect of x on who wins the individuals when the group multi-homes)*** *When the group joins both platforms, there is a unique threshold, $\widehat{x}_M$, where $\widehat{x}_M$ is the solution to $V_{A1} = V_B(\widehat{x}_M)$, such that when $x \in [0, \widehat{x}_M]$, platform A wins the individuals; otherwise, platform B wins the individual. Moreover, $\widehat{x}_M > \widehat{x}$.*

Note that the threshold found in Lemma 2 is different than the one identified in Lemma 1 as well as from the threshold identified in Proposition 1. The intuition behind the result that $\widehat{x}_M > \widehat{x}$ is that when the group multi-homes, the individual users can "meet" the group either on platform A or B. As a result, the group has a weaker effect on which platform wins the market.

We now consider the first stage where platforms compete on attracting the group. We assume that when the group joins both platforms, each group user interacts with other users only once, and therefore receives the network effects from other users only in one of the platforms. This assumption implies that the group's ability to multi-home does not directly increase total welfare (through the number of interactions between users), and may only affect welfare indirectly through the group's ability of assist platform B to win the market. As users may interact with some users on one platform and other users on another platform, we make the simplifying assumption that the quality gap between platforms is independent of the size of network effects. That is, $V_B(n) - V_A(n)$ is constant and equals to V_{B0} for all n. This assumption implies that when the group joins both platforms, regardless of what platform the individual users join, a group-user gains V_{B1}.[19]

Given that the group can multi-home, the price a platform charges in the first stage should make the group indifferent between joining only the competing platform and joining both platforms. Lemma 3 identifies the group's decision as a function of x:

Lemma 3. ***(Competition on the group)*** *In equilibrium, the group always joins both platforms.*

Lemma 3 shows that in equilibrium, the group always joins both platforms. Intuitively, platform B can always attract the group by charging it at most platform B's base quality. Likewise, platform A can attract the group by charging at most 0. Therefore, we have that individual users join platform B iff $\widehat{x}_M < x$. That is, whether multi-homing improves or worsens the coordination failure depends on whether $\widehat{x}_M$ is larger or smaller than $\widetilde{x}$ – the threshold identified under the single-homing case. As shown in the proposition, we find that $\widetilde{x} < \widehat{x}_M$–i.e., multi-homing worsens the coordination failure problem.

Proposition 6. ***(Under multi-homing, larger group required for efficient outcome)*** *As compared to single-homing, when the group can multi-home, a larger group size is required for the more efficient platform, B, to win the market; i.e.,* $\widetilde{x} < \widehat{x}_M$.

The intuition for this result is that when the group multi-homes it has a lower ability to affect the winning platform (as shown by Lemma 2). In this case, the two platforms have less of an incentive to compete on attracting the group. This goes against platform B that generally earns less from attracting the group than platform A. Taken together, the proposition implies that multi-homing reduces the group's ability to mitigate the coordination problem. Moreover, the group assists the inefficient platform in maintaining its dominant position.

This result has interesting implications for exclusive dealing. Specifically, it is easy to show that for $0 < x < \widetilde{x}$, total social welfare under multi-homing is higher than under single-homing as under multi-homing the group users enjoy both the network

[19] Our results hold if instead we assume that the group users get their network effects from the platform the individual users join.

effect (V_{A1}) and the quality advantage (V_{B0}). This is in contrast to the single-homing case, where in this region platform A wins the market and all users enjoy the network effect but not the quality advantage. For $\widetilde{x} < x < \widehat{x}_M$, however, under single-homing platform B wins the market (Proposition (1)) while under multi-homing the individual users still choose platform A. That is, in this case, total social welfare is higher under single-homing where *all* users enjoy both the network effect and the quality advantage as opposed to the multi-homing case where only the group users enjoy the quality advantage. This suggests that in markets with intermediate sized group, exclusive dealing where the group commits to join only one of the platforms, may help the market coordinate on the more efficient platform and as a result increase total social welfare.[20]

These results shed new light on policy towards multi-homing. In the report for the European Commission, Crémer, de Montjoye and Schweitzer (2019) raise the concern that network effects may prevent a superior entrant platform from overtaking an inferior incumbent. This potential inefficiency is the focus of our paper. One of the report's recommendations is that "In order to encourage exploration by consumers and to allow entrant platforms to attract them through the offer of targeted services, it is important to ensure that multi-homing is possible and that dominant platforms do not impede its practice." (pp 57). Our paper identifies an anti-competitive effect of multi-homing. Namely, multi-homing by a user-group can help an inferior incumbent platform - maintain its dominant position.

The result in Proposition 6 differs from Doganoglu and Wright (2010) who consider platform competition between an incumbent and a more efficient entrant. The incumbent platform can make an introductory offer to a subset of users, who can multi-home. They find that if the incumbent cannot impose exclusive contracts on the initial set of users, the market overcomes the coordination failure problem and all users choose to join the more efficient entrant. We contribute to this literature by showing that when the remaining users' decision depends not only on the initial users' decisions but also on their beliefs about what other users choose, multi-homing does not mitigate the coordination failure problem and the more efficient platform cannot overcome its competitive disadvantage. In fact, multi-homing makes the coordination problem more severe.

[20] Note that for $\widehat{x}_M < x$, total social welfare under single- and multi-homing is the same.

6.2 The group affects the individual users' beliefs

Our base model assumes that the group cannot affect the beliefs of individual users. That is, platform A is focal for $J = \{A, B\}$. This assumption is reasonable when the group is of small proportion. Indeed, recall that the base model's results hold even when $x < \frac{1}{2}$. Yet, a large enough group may affect the beliefs of the individual users where the larger the group, the stronger the effect.

This subsection considers the case where the group can directly affect the beliefs of the individual users. We argue that the stronger the effect of the group on the beliefs of the individual, the more likely the group to join the high-quality platform. To illustrate this argument, we consider the extreme case in which the group determines the beliefs of the individual users: the platform that wins the group becomes focal.

When the group can decide which platform is focal (by joining that platform), the group is always pivotal (i.e., for all values of $0 \leq x \leq 1$). In this case, according to Lemma 1, if platform A wins the group, it wins the individual users and earns from them $\pi_A(x; A) = (1-x)(V_{A1} - V_{B0})$. Similarly, when platform B wins the group and benefits from the focal position, it wins the individuals and earns $\pi_B(x; B) = (1-x)V_{B1}$. The following proposition shows that in this case, platform B always wins the group and individual users:

Proposition 7. ***(When the group determines the focal platform,*** B ***always wins)*** *Suppose that the platform that wins the group becomes focal. Then, for all* $0 \leq x \leq 1$*, platform* B *wins the group and individual users.*

The intuition for this result is that when the platform that wins the group becomes focal, both platforms can use the group in order to collect the network effects the individual users create to each other. In this case, the joint value of the group and a focal platform B is always larger than with a focal platform A: $V_{B1} > V_{A1}$. That is, platform B can use its superior quality in order to attract the group and consequently win the individual users. This result implies that the stronger the group's ability to affect the beliefs of the individual users, the more likely the group to make the efficient choice and join platform B.

Hałaburda and Yehezkel (2019) consider platform competition when one of the platforms benefits from a partial degree of focality. Using their notion of focality, the group in our model may have a partial effect on the degree of focality, which is an increasing function of the size of the group. In such a case, platform B may not always win the market. Still, its ability to win the market increases as the size of the group has a stronger effect on the degree of focality.

6.3 The group cannot make a collective decision

In this subsection we ask how the group's ability to make a collective decision affects the results. Recall that the group makes its platform decision before the individual users. This raises the question whether the group's ability to mitigate the coordination problem is mainly driven by the coordinated decision or the sequential aspect of our game. To study this, we look at how the results change when an uncoordinated group chooses a platform before the (uncoordinated) individual users. The main conclusion of this subsection is that when the group cannot make a collective decision, a pivotal uncoordinated group is more likely to join platform A. Moreover, if the quality gap between platforms is not too large, then an uncoordinated group joins platform A for all group sizes, $x \in [0, 1]$. These results imply that the group has a stronger ability to help the high-quality platform win the market when it can coordinate the decisions of its group members.

Suppose that in the first stage, platforms A and B compete on a group of users with proportion x. Group-users make individual decisions: each group user takes the decisions of other group users as given and believes that platform A is focal. In the second stage, platforms compete on individual users.

The second stage is identical to our base model: the group is pivotal iff $x > \widehat{x}$ and the profits of the two platforms from individual users are given by Lemma 1. Turning to stage 1, recall that when the group makes a collective decision, a pivotal group knows that if the group chooses platform B, all group members and individual users would join that platform. An uncoordinated group user, in contrast, expects other group and individual users to join platform A. This makes it harder for platform B to attract the uncoordinated group-users than the coordinated group. Solving the model given the above-mentioned differences, we have the following result:

Proposition 8. ***(A pivotal non-coordinated group is less likely to choose platform*** B***)*** *Suppose that group-users cannot make a coordinated decision. Then, platform* A *wins the market when* $x \in [0, \widetilde{x}]$ *and at least when* x *is slightly higher than* $\widetilde{x}$ *or when* x *is slightly lower than* 1.

Proposition 8 shows that platform A is more likely to win the market when the group cannot make a coordinated decision. The result that platform A wins at least when x is close to $\widetilde{x}$ or 1 suggests that platform A may win the market for all $x \in [0, 1]$. Indeed, based on the linear utility considered in subsection 4.2, we find that when the quality gap in favor of platform B is not too large, $Q < 0.657\lambda$, platform A wins for all values of $x \in [0, 1]$. When platform B is of significantly higher quality, $Q > 0.657\lambda$, there are two cutoffs, $\widetilde{\widetilde{x}}_1$ and $\widetilde{\widetilde{x}}_2$ where $\widetilde{x} < \widetilde{\widetilde{x}}_1 < \widetilde{\widetilde{x}}_2 < 1$ such that platform B wins for $\widetilde{\widetilde{x}}_1 < x < \widetilde{\widetilde{x}}_2$. Figure 6 illustrates these cutoffs.

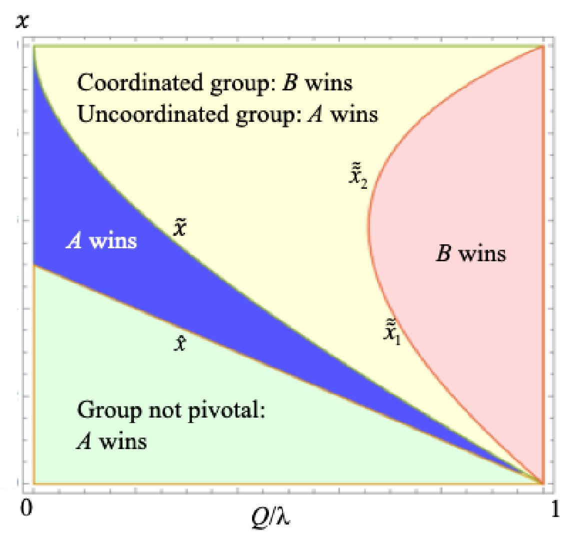


Figure 6: The cutoff values of $\widetilde{x}$, $\widetilde{\widetilde{x}}_1$ and $\widetilde{\widetilde{x}}_2$ as a function of Q

Intuitively, the two platforms compete on two distinct subgroups of users and can price discriminate between them. As suggested by Caillaud and Jullien (2001; 2003), for a non-focal platform to win the market, the platform needs to adopt a divide-and-conquer strategy: the platform can subsidize the first group of users and then collect the revenues from the other group. Figure 6 shows that when the first group cannot make a collective decision, the ability of the non-focal platform B to win the market with a divide-and-conquer strategy either substantially decreases (when $Q > 0.657\lambda$) or completely vanishes (when $Q < 0.657\lambda$). Without coordination, group users expect other group users to join the focal platform and do not internalize their ability to affect the decisions of individual users. This makes it more profitable for the focal platform to maintain its dominant position.

This result implies that the weaker the group's ability to coordinate the decisions of its members, the less the high-quality but non-focal platform can utilize the group to win the market. For example, the ability of the low-quality, focal platform A to win the market increases when the market is composed of several small user-groups. Even once one moves from one group to two groups with proportions x_1 and x_2, the two groups may have a lower ability to help the high-quality platform win as compared to one group with proportion $x = x_1 + x_2$. For policy towards user-merger, this insight implies that a merger between users to a group that is large enough to help move the market away from a dominant low-quality platform, may instead preserve this dominance.

6.4 Horizontally differentiated platform

Our model assumes that users are homogeneous in their preferences towards the two platforms. Naturally, in this case, in equilibrium only one platform is active. It is intuitive to expect that when the two platforms are horizontally differentiated, both platforms are active because some users have strong preferences towards a specific platform, and would join it regardless of the decisions of other users. In this subsection we comment on how the degree of product differentiation affects the group's incentive to join the high-quality platform.

Suppose that the two platforms are horizontally differentiated: users vary in their preferences towards each platform. In such a case, platform A's focality advantage becomes weaker because some users join platform B even if they expect other users (and the group) to join platform A. The network effects these loyal users generate makes it harder for platform A to overcome its quality disadvantage. Thereby, making it easier for platform B to attract the group (i.e., platform B can win the group for a smaller quality advantage).

In Appendix C we confirm this intuition with a simple model of horizontally differentiated platforms. For tractability, we assume that some users are loyal to a specific platform and would only consider buying from it or not buying at all. The analysis shows that when the degree of product differentiation (measured by the proportion of loyal users) is small, platform A wins a pivotal group in a similar way to our base model. In equilibrium, both platforms gain positive market share, though platform A's share of individual users is larger due to its focal position and its ability to attract the group. As expected, the parameter space in which the group joins platform A diminishes as product differentiation increases. For high degree of product differentiation, a pivotal group always joins platform B. This is because most consumers care more about their own subjective preferences toward a specific platform and less about the decisions of other users. When the two platforms are almost two monopolies, the group joins platform B even when it is not pivotal.

For policy towards user-groups, these results indicate that a merger between users to a user-group is more harmful the more homogeneous the platforms. In such markets, it is more likely that a user-group would enhance the focality advantage of a low-quality incumbent rather than mitigate it.

7 Conclusion

This paper considers platform competition when some users belong to a user-group. The group chooses collectively which platform to join, while small, individual users make individual decision. One of the platforms is of low-quality, but benefits from a focality advantage: individual users expect that other individual users will join it. Such focality can emerge from incumbency advantage or users' inertia towards a platform that users joined in the past.

The model reveals three main results. First, a large group that can solve users' coordination problem by joining the high-quality platform may choose to join the low-quality platform. This happens because the low-quality focal platform is better positioned to subsidize the group, as the focal platform can extract the network effects the individual users create to each other. When the proportion of the group is large, the pivotal group joins the high-quality platform. In this case, the quality advantage is more beneficial to the group than earning the focal platform's revenues from serving the non-users.

The second main result is that an increase in the proportion of the group has a non-monotonic effect on the individual utility of group and individual users. When the size of the group is small, the group is not pivotal and an increase in the proportion of the group increases the utility of each of its members, while keeping the utility of individual members fixed. When the group becomes pivotal, each of its members earns additional payoff, even when it continues to choose the low-quality platform. When the group chooses the high-quality platform, a further increase in its proportion decreases the utilities of each member inside and outside the group. For group users, the alternative of joining the low-quality platform becomes less attractive, making it possible for the high-quality platform to attract it with a higher price. The utility of an individual user decreases with the proportion of group users because the non-focal platform extracts the network effects that the group provides to the individual users.

The third main result is that some market conditions may enhance or diminish the group's ability to correct the users' coordination failure. When the group can multi-home, it is more likely that the low-quality platform maintains its dominance. Likewise, a group's ability to help the high-quality platform to overcome unfavorable position decreases the more platforms are homogeneous, the less the group can coordinate the decisions of its members and the less the group can directly affect beliefs.

Our results shed new light on public policy towards user-mergers and other formations of a user-group.[21] Generally, user-mergers may have anti-competitive effects that are outside our model, such as eliminating competition between application developers or restaurants chains. These anti-competitive effects may harm the end consumers of the platforms' users. At the same time, user-mergers may enhance the efficiency of platform competition when a large user helps a high-quality platform to overcome an incumbency advantage of a low-quality competitor. Yet, our model suggests that this potential positive effect of a user-group deserves a cautious approach for two reasons. First, when the user-group is in a position to help a high-quality platform to overcome a non-focal position, the user-group may still team up with the low-quality, focal platform. Second, even when a user-group makes the "right" decision of joining the high-quality platform, an increase in the proportion of the group may decrease the utilities of both group and individual users.

Our paper assumes that the focal platform is of low quality. In practice, the group may affect the base quality of the platform. For example, data-driven platforms can use the large set of data generated by the group to offer better quality. If such increase in quality can benefit only the incumbent, our results would become stronger, as this provides another incentive for the group to join the focal platform. When both platforms can enhance their qualities once the group joins one of them, our results depend on the relative size of this increase. For example, if the group can enhance the quality of each platform by the same level, our results would remain unchanged.

Our model focuses on a one-side market. The formation of a user-group in a two-sided markets raises two interesting questions that we leave for future research. First, as Caillaud and Jullien (2001) and (2003) show, in a two-sided market, platform competition is typically asymmetric: platforms adopt a "divide-and-conquer" strategy in which they compete more aggressively on one of the sides, and extract their revenues from the other side. This raises the question of how the presence of a user-group affects

[21] For example, the non-focal platform may choose to forward-integrate to form a large group or may encourage users to move together as a group and make a collective choice.

such asymmetric competition and the platforms' decision which side of the market to "divide" or "conquer". Second, a user-group can form on one side of the market. Alternatively, different groups can emerge on each side of the market. For example, the market for mobile operating systems includes a user-side and an application developers side. The user-side can form a user-group through a large cellular carrier. Likewise, developers can form a user-group through mergers between application developers. This raises the question of how the identity of the side that the group belongs to affects market efficiency, and how our results change in the presences of user groups on both sides of the market. Since the focus of this paper is on coordination and focality, we leave these questions for future research.

Appendix

Below are the proofs for all lemmas and propositions in the text.

Proof of Lemma 1: Suppose first that $J = A$. An equilibrium in which platform A wins the individual users satisfies the following conditions. First, prices for the individual users are:

$$V_{A1} - p_A \geq V_{B0} - p_B, \quad p_B = 0 \quad \Longrightarrow \quad p_A = V_{A1} - V_{B0}. \tag{13}$$

That is, platform A charges the highest price that ensures that individual users prefer joining the focal platform A over joining platform B, given that all other individual users (and all the group users) are on platform A. Platform B charges the lowest price that ensures non-negative profits. The second condition is that platform A earns positive profit from attracting the individual users. Recalling that $\pi_i(x; J) = p_i(1-x)$ and using (13), we have:

$$\pi_A(x; A) = (1-x)p_A = (1-x)\left(V_{A1} - V_{B0}\right) > 0, \tag{14}$$

where the inequality follows from Assumption 3. Hence, given $J = A$, there is an equilibrium in which platform A wins the individuals. To see that given $J = A$ there is no equilibrium in which platform B wins the individuals, note that if such equilibrium were to exist, $p_A = 0$ and $V_{A1} - p_A = V_{B0} - p_B$, implying that $p_B = V_{B0} - V_{A1}$ and platform B earns: $\pi_B(x; A) = (1-x)\left(V_{B0} - V_{A1}\right) < 0$. Hence, when $J = A$, platform A always wins the individual users.

Suppose now that $J = B$. Section 3 shows that there is an equilibrium in which platform A wins the individual users when $V_A(1-x) > V_B(x)$. In an equilibrium in which platform B wins, it charges and earns, respectively,

$$p_B = V_B(x) - V_A(1-x), \quad \pi_B(x, B) = (1-x)\left(V_B(x) - V_A(1-x)\right). \tag{15}$$

Hence, $\pi_B(x, B) = -\pi_A(x, B)$ and platform A wins the individual users iff $V_A(1-x) \geq V_B(x)$.

To complete the the proof, we show that $V_A(1-x) > V_B(x)$ iff $x < \widehat{x}$ where $0 < \widehat{x} < \frac{1}{2}$. Evaluating $V_A(1-x) - V_B(x)$ at $x = 0$, $V_A(1-0) - V_B(0) = V_{A1} - V_{B0} > 0$, where the last inequality follows from Assumption 3. Evaluating $V_A(1-x) - V_B(x)$ at

$x = \frac{1}{2}$, $V_A(1-\frac{1}{2}) - V_B(\frac{1}{2}) = V_A(\frac{1}{2}) - V_B(\frac{1}{2}) < 0$, where the last inequality follows from Assumption 2. Since by Assumption 1, $V_A(1-x)$ is decreasing with x and $V_B(x)$ is increasing with x, there is a unique $x < \frac{1}{2}$ such that $V_A(1-x) > V_B(x)$ iff $x < \widehat{x}$. ■

Proof of Proposition 1:

Part (i):

Evaluating (7) at $x = \widehat{x}$:

$$\begin{aligned}
\Pi_A(\widehat{x}; A) &= (V_{A1} - V_{B0}) - (1-\widehat{x})\,(V_B(\widehat{x}) - V_A(1-\widehat{x})) - \widehat{x}\,(V_{B1} - V_{B0}) \\
&= (V_{A1} - V_{B0}) - \widehat{x}\,(V_{B1} - V_{B0}) \\
&\geq (1-\widehat{x})V_{A1} - V_{B0} \\
&\geq V_A(1-\widehat{x}) - V_{B0} \\
&= V_B(\widehat{x}) - V_{B0} \\
&> 0,
\end{aligned}$$

where the equality in the second line follows because by definition, $V_B(\widehat{x}) = V_A(1-\widehat{x})$, the inequality in the third line follows since $V_{B1} - V_{B0} \leq V_{A1}$ (and rearranging), the inequality in the fourth line follows because the convexity of $V_A(n)$ together with $V_{A0} = 0$ imply that $(1-\widehat{x})V_{A1} = \widehat{x}V_A(0) + (1-\widehat{x})V_A(1) \geq V_A(\widehat{x}\times 0 + (1-\widehat{x})\times 1) = V_A(1-\widehat{x})$, the equality in the fifth line follows again because $V_B(\widehat{x}) = V_A(1-\widehat{x})$ and the inequality in the last line follows from Assumption 1. Since the last inequality is strong, $\Pi_A(\widehat{x}; A) > 0$ also holds when $V_A(n)$ is linear or concave in n, as long as it is not too concave, and when $V_{B1} - V_{B0} > V_{A1}$ as long as the gap is not too large.

Part (ii):

Evaluating (7) at $x = 1$:

$$\begin{aligned}
\Pi_A(1; A) &= (V_{A1} - V_{B0}) - (V_{B1} - V_{B0}) \\
&= V_{A1} - V_{B1} \\
&< 0,
\end{aligned}$$

where the inequality follows from Assumption 3. Since $\Pi_B(x; B) = -\Pi_A(x; A)$, it follows that $\Pi_B(1; B) > 0$.

Part (iii):

The plan of the proof is as follows. First, we show that $\frac{d\Pi_A(x;A)}{dx}|_{x=\widehat{x}} < 0$ and $\frac{d\Pi_A(x;A)}{dx}|_{x=1} > 0$. Second, we show that $\frac{d^2\Pi_A(x;A)}{d^2x} > 0$ whenever condition (9) holds. These two results would indicate that $\Pi_A(x;A)$ is a U-shape function of x. Recall from parts (i) and (ii) of the proof that $\Pi_A(\widehat{x};A) > 0$ and $\Pi_A(1;A) < 0$. This means that starting at $x = \widehat{x}$, $\Pi_A(\widehat{x};A) > 0$. Then, $\Pi_A(x;A)$ decreases with x, but since $\Pi_A(1;A) < 0$ and $\frac{d\Pi_A(x;A)}{dx}|_{x=1} > 0$, it has to be that there is a cutoff, $\widetilde{x}$, where $\Pi_A(\widetilde{x};A) = 0$, such that $\Pi_A(x;A) > 0$ iff $x < \widetilde{x}$. When x increases further above $\widetilde{x}$, $\Pi_A(x;A)$ continues to decrease with x, and then $\Pi_A(x;A)$ starts to increase with x (though remains negative because $\Pi_A(1;A) < 0$). Finally, since $\Pi_B(x;B) = -\Pi_A(x;A)$, we have that the same cutoff satisfies that $\Pi_B(x;B) > 0$ iff $x > \widehat{x}$.

We start with $\frac{d\Pi_A(x;A)}{dx}$:

$$\frac{d\Pi_A(x;A)}{dx} = -\left(V_{B1} - V_{B0}\right) + \left(V_B(x) - V_A(1-x)\right) - (1-x)\left(V_B'(x) + V_A'(1-x)\right). \quad (16)$$

Evaluated at $x = \widehat{x}$, the term in the second large brackets in (16) disappears because by definition, $V_B(\widehat{x}) - V_A(1-\widehat{x}) = 0$, we get

$$\left.\frac{d\Pi_A(x;A)}{dx}\right|_{x=\widehat{x}} = -\left(V_{B1} - V_{B0}\right) - (1-\widehat{x})\left(V_B'(\widehat{x}) + V_A'(1-\widehat{x})\right) < 0,$$

where the inequality follows because $V_i'(n) > 0$. Evaluated at $x = 1$:

$$\left.\frac{d\Pi_A(x;A)}{dx}\right|_{x=1} = -\left(V_{B1} - V_{B0}\right) + \left(V_{B1} - 0\right) = V_{B0} > 0.$$

Next, differentiating (16) with respect to x yields that $\frac{d^2\Pi_A(x;A)}{d^2x} > 0$ when condition (9) holds (notice that when $\pi_B(x;B)$ is concave in x, $\Pi_B(x;B)$ is also concave in x and therefore $\Pi_A(x;A)$ is convex in x). ■

Proof of Proposition: 2

The first part of the proof shows that when $x < \widehat{x}$, there is an equilibrium in which platform A wins the group. The second part shows that this equilibrium is unique.

Starting with the first part, an equilibrium in which platform A wins the group has to satisfy the following conditions. First, platform B charges the lowest price that ensures non-negative profit and platform A charges the highest price possible that still compels the group to join it, given that it also wins the individual users:

$$xV_{A1} - p_A^G \geq xV_B(x) - p_B^G \quad , p_B^G = 0 \Longrightarrow \quad p_A^G = x\left(V_{A1} - V_B(x)\right). \tag{17}$$

Second, it is advantageous for platform A to win the group, over giving up on it and serving only individual users: $\pi_A(x;A) + p_A^G \geq \pi_A(x;B)$. Substituting (14) and (17) into $\Pi_A(x;A) = \pi_A(x;A) + p_A^G$, we have:

$$\Pi_A(x;A) = V_{A1} - (1-x)V_{B0} - xV_B(x). \tag{18}$$

In this case, there is an equilibrium in which platform A wins the group iff: $\Pi_A(x;A) > \pi_A(x;B)$. That is, platform A's profit from serving both group and individual users are higher than serving only the individuals and letting platform B win the group. Recall that $\pi_A(x;B) = (1-x)\left(V_A(1-x) - V_B(x)\right)$. Plugging in equation (18), we have:

$$\begin{aligned}
&\Pi_A(x;A) - \pi_A(x;B) \\
&= V_{A1} - (1-x)\left(V_{B0} + V_A(1-x)\right) + (1-2x)V_B(x) \\
&> V_{A1} - (1-x)\left(V_{B0} + V_A(1-x)\right) + (1-2x)V_{B0} \\
&> V_{A1} - (1-x)\left(V_{B0} + V_{A1}\right) + (1-2x)V_{B0} \\
&= x\left(V_{A1} - V_{B0}\right) \\
&> 0,
\end{aligned} \tag{19}$$

where the first inequality follows because $V_B(x) > V_{B0}$ and from Lemma 1, $x < \widehat{x} < \frac{1}{2}$. The second inequality follows because $V_A(1-x) < V_{A1}$, and the last inequality follows from Assumption 3. Hence, there is an equilibrium in which platform A wins the group.

Next, consider a putative equilibrium in which platform B wins the group (and platform A wins the individuals) . In such an equilibrium, if it were to exist, platform A charges the highest price that makes it indifferent between winning and not winning the group: $p_A^G = -\left(\pi_A(x;A) - \pi_A(x;B)\right)$. The highest price that platform B can charge the group solves

$$xV_B(x) - p_B^G \geq xV_{A1} - p_A^G,$$

hence, $p_B^G = -\left(\pi_A(x;A) - \pi_A(x;B)\right) - x\left(V_{A1} - V_B(x)\right)$. Platform B earns $\Pi_B(x;B) = p_B^G$, because B cannot win the individuals even when $J = B$. Yet, notice that $\Pi_B(x;B) = \pi(x;A) + x\left(V_{A1} - V_B(x)\right) - \pi_A(x;B) < 0$, where the inequality follows from (19), implying that there is no equilibrium in which platform B wins. ■

Proof of Proposition 3:
When $x < \widetilde{x}$, it follows immediately from (11) that $u(x)$ is independent of x. Next consider the case where $x \geq \widetilde{x}$. We start by evaluating $u(\widetilde{x})$. Extracting $V_B(\widetilde{x})$ from the definition of $\widetilde{x}$ (equation (7) in equality) and substituting into the second line in (11), we can rewrite $u(x \to \widetilde{x}^+) = V_{B0} + \frac{V_{B1}-V_{A1}}{1-\widetilde{x}}$. Recalling that $u(x \to \widetilde{x}^-) = V_{B0}$, we have that $u(x \to \widetilde{x}^+) - u(x \to \widetilde{x}^-) = \frac{V_{B1}-V_{A1}}{1-\widetilde{x}} > 0$, where the inequality follows from Assumption 2. Next, we have that for $x > \widetilde{x}$, $u'(x) = -V_B'(x) - V_A'(1-x) < 0$ where the inequality follows from Assumption 1. Finally, $u(1) = V_{B1} - (V_B(1) - V_A(1-1)) = 0$. ■

Proof of Proposition 4:
Starting with part (i), it follows from Assumption 1 that when $x \in [0, \widehat{x})$, $u^G(x) = V_B(x)$ is increasing with x.

Moving to part (ii), we first show that there is a discontinuous jump in $u^G(\widehat{x})$. To this end, recall that $V_B(\widehat{x}) = V_A(1-\widehat{x})$. Substituting $V_B(\widehat{x}) = V_A(1-\widehat{x})$ into the second line in (12) yields that $u^G(x \to \widehat{x}^+) = V_{B1} > V_B(\widehat{x}) = u^G(x \to \widehat{x}^-)$, where the inequality follows because $\widehat{x} < 1$ and $V_B(x)$ is increasing with x. Next we turn to showing that evaluated at $x = \widehat{x}$, $u^G(x)$ is increasing in x. To this end, differentiating the second line of (12) with respect to x:

$$\frac{du^G(x)}{dx} = \frac{[V_A(1-x) - V_B(x)] + x(1-x)\,[V_A'(1-x) + V_B'(x)]}{x^2}.$$

Evaluated at $V_B(\widehat{x}) = V_A(1-\widehat{x})$, the term in the first squared brackets vanishes. The term in the second squared brackets is positive by Assumption 1. Hence, $\frac{du^G(\widehat{x})}{dx} > 0$.

Turning to part (iii), we have:

$$\frac{du^G(x)}{dx} = -\frac{V_{A1} - V_{B0}}{x^2} < 0,$$

where the inequality follows from Assumption 3. ■

Proof of Proposition 5:
Part (i): We start with the first line of $\Pi(x)$: $x \in [0, \widehat{x})$. We have $\Pi(0) = V_{A1} - V_{B0}$. Moreover,

$$\Pi'(x) = V_{B0} - V_B(x) - xV_B'(x) < 0,$$

where the inequality follows because for all $x > 0$, $V_B(x) > V_{B0}$ and $V_B(x)$ increases with x, (notice that $\Pi''(x) = -2V_B'(x) - xV_B''(x)$). Evaluating $\Pi(x)$ at $x \to \widehat{x}^-$ (first line in $\Pi(x)$) and $x \to \widehat{x}^{+}$ (second line in $\Pi(x)$), we have $\Pi(x \to \widehat{x}^{-}) = V_{A1} - V_{B0} - \widehat{x}\left(V_B(\widehat{x}) - V_{B0}\right)$ and $\Pi(x \to \widehat{x}^{+}) = (V_{A1} - V_{B0}) - \widehat{x}\left(V_{B1} - V_{B0}\right)$ (where recall that $V_A(1-\widehat{x}) = V_B(\widehat{x})$). The gap:

$$\Pi(x \to \widehat{x}^{-}) - \Pi(x \to \widehat{x}^{+}) = \widehat{x}\left(V_{B1} - V_B(\widehat{x})\right) > 0.$$

Hence, there is a discontinuous drop in $\Pi(\widehat{x})$.

Next, consider the second line of $\Pi(x)$: $x \in [\widehat{x}, \widetilde{x})$. From the proof of Proposition 3, $\Pi(x) = \Pi_A(x; A)$ is decreasing and convex in x and $\Pi(\widetilde{x}) = 0$.

Next, consider the third line of $\Pi(x)$: $x \in [\widetilde{x}, 1]$. Again from the proof of Proposition 1, $\Pi(\widetilde{x}) = \Pi_B(\widetilde{x}; B) = 0$, hence, $\Pi(x)$ is continuous at $\widetilde{x}$. Moreover, $\Pi(x) = \Pi_B(x; B)$ is an inverse U-shape function of x.

Part (ii): Starting with $x \in [0, \widetilde{x})$, we have $CS(0) = V_{A1} - \Pi(0) = V_{B0}$. Because $\Pi(x)$ is decreasing in x, and has discontinuous decline at $x = \widehat{x}$, $CS(x)$ is increasing in x and has a discontinuous climb at $x = \widehat{x}$. At $x = \widetilde{x}$, $\Pi(\widetilde{x}) = 0$, but total utility increases from V_{A1} to V_{B1} , hence, there is a discontinuous climb in $CS(\widetilde{x})$. Finally, at $x \in [\widetilde{x}, 1]$, $\Pi(x) = \Pi_B(x; B)$ is an inverse U-shape function of x, hence $CS(x)$ is a U-shape function of x. Finally, $CS(1) = V_{B1} - \Pi_B(1, B) = V_{A1} < V_{B1} = CS(\widetilde{x})$. ■

Proof of Lemma 2:

Suppose the group joins platforms A and B and now the two platforms compete on the individual users. In this case, individual users compare their value from choosing A, i.e., $V_{A1} - p_A$, with their value from choosing B, i.e., $V_B(x) - p_B$. In an equilibrium where platform A wins the individual users, A charges the highest price that ensures the individual users prefer joining its focal platform over joining platform B: $V_{A1} - p_A \geq V_B(x) - p_B$. Platform B then charges the lowest price that ensures non-negative profits: $p_B = 0$; implying that $p_A = V_{A1} - V_B(x)$. Using the same logic, in an equilibrium where platform B wins the individual users, prices would be set to $p_A = 0$; $p_B = V_B(x) - V_{A1}$. Let $\pi_i(x; AB)$ denote the profit of platform $i = A, B$ from the individual users, given that the group joined both platforms. Since $p_A = -p_B$, we have $\pi_A(x; AB) = -\pi_B(x; AB) = (1-x)\left(V_{A1} - V_B(x)\right)$ where platform A wins the individual users iff $\pi_A(x; AB) > 0$, i.e., $V_{A1} > V_B(x)$.

Next, we show that $V_{A1} > V_B(x)$ iff $x < \widehat{x}_M$, where $\widehat{x}_M$ is the solution to $V_{A1} = V_B(\widehat{x}_M)$. Recall that $V_{A1} - V_B(0) = V_{A1} - V_{B0} > 0$, $V_{A1} - V_B(x)$ is decreasing with x, and that $V_{A1} - V_B(1) = V_{A1} - V_{B1} < 0$. Hence, there is a unique $\widehat{x}_M$ such that

$V_{A1} > V_B(x)$ iff $x < \widehat{x}_M$. To show that $\widehat{x}_M > \widehat{x}$, recall that $V_A(1-\widehat{x}) = V_B(\widehat{x})$ and $V_{A1} - V_B(\widehat{x}_M) = 0$. Hence $V_{A1} - V_B(\widehat{x}) = V_{A1} - V_A(1-\widehat{x}) > 0$, implying that at $x = \widehat{x}$, $\pi_A(x; AB) > 0$ and $\widehat{x}_M > \widehat{x}$. ■

Proof of Lemma 3:
To prove that the group always joins both platforms, we distinguish between three cases: *i)* $x < \widehat{x}$; *ii)* $\widehat{x} < x < \widehat{x}_M$ and *iii)* $\widehat{x}_M < x < 1$.

Part (i): $x < \widehat{x}$. The two platforms should set prices such that the group is indifferent between multi-homing and single-homing on the competing platform. Since for $x < \widehat{x}$, the individual users choose platform A, regardless of the group's choice, platform A should set its price such that the group is indifferent between joining only platform B and gaining $xV_B(x) - p_B^G$ and joining both platforms and gaining $xV_{B1} - p_A^G - p_B^G$.[22] Similarly, platform B sets its price to make the group indifferent between joining only platform A and gaining $xV_{A1} - p_A^G$ and joining both platforms. To summarize, the two platforms set their prices $p_A^G = x(V_{B1} - V_B(x))$ and $p_B^G = x(V_{B1} - V_{A1}) = xV_{B0}$ and the group joins both platforms. Note that both $p_A^G > 0$ and $p_B^G > 0$.

Part (ii): $\widehat{x} < x < \widehat{x}_M$. Consider first platform A. Given that under single-homing the group is pivotal ($x > \widehat{x}$), if the group joins only B, it gains $xV_{B1} - p_B^G$. As before, if the group multi-homes, the group gains $xV_{B1} - p_A^G - p_B^G$. That is, A sets its price to zero. While this may suggest that A might not find it optimal to attract the group, recall that if A does not attract the group, the group joins B and A loses the individual users. If, however, A attracts the group, according to Lemma 2, it wins the individual users, and since $p_A > 0$ earns positive profit. Hence, A strongly prefers attracting the group.

Platform B's decision is identical to the case where $x < \widehat{x}$, as in both cases if the group joins both platforms, A wins the individual. So, as before, B finds it optimal to attract the group and sets its price to $p_B^G = xV_{B0}$. To summarize, prices are $p_B^G = xV_{B0}$; $p_A^G = 0$ and the group joins both platforms.

Part (iii): $\widehat{x}_M < x < 1$. Since in this region x is still larger than $\widehat{x}$, just like before, if the group only joins platform B it gains $xV_{B1} - p_B^G$. Also as before, if the group multi-homes it gains $xV_{B1} - p_A^G - p_B^G$. That is, here again the most platform A can charge is p_A^G=0. In contrast to the previous case, regardless of whether platform A attracts the

[22] Recall that we assume that the quality gap between platforms is independent of the size of the network effects and thus, regardless of the individual users' choice, under multi-homing a group-user gains V_{B1}.

group, according to Lemma 2, the individual users choose platform B. Consequently, A is indifferent between attracting and not attracting the group as in both cases it gains 0.

Platform B still needs to set a price that makes the group indifferent between joining only A and gaining $xV_{A1} - p_A^G$ (as the individual would join A as well) and multi-homing and gaining $xV_{B1} - p_A^G - p_B^G$. So, again, B finds it optimal to attract the group and sets its price to $p_B^G = xV_{B0} > 0$. To summarize, prices are $p_A^G = 0$ and $p_B^G = xV_{B0}$ and the group joins both platforms. ■

Proof of Proposition 6:
We proved that the group always multi-homes in Lemma 3. Thus, we only prove here that the threshold $\widehat{x}_M$ that solves $(1-x)(V_{A1} - V_B(x)) = 0$ is higher than the threshold $\widetilde{x}$ that solves $(1-x)(V_A(1-x) - V_B(x)) + (V_{A1} - V_{B0}) - x(V_{B1} - V_{B0}) = 0$. To this end, we show that evaluated at $\widehat{x}_M$, the equation that $\widetilde{x}$ solves is negative; i.e.:

$$(1-\widehat{x}_M)(V_A(1-\widehat{x}_M) - V_B(\widehat{x}_M)) + (V_{A1} - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}) < 0.$$

We know that

$$(1-\widehat{x}_M)(V_A(1-\widehat{x}_M) - V_B(\widehat{x}_M)) + (V_{A1} - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}) <$$

$$(1-\widehat{x}_M)(V_{A1} - V_B(\widehat{x}_M)) + (V_{A1} - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}) =$$

$$= (V_{A1} - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}),$$

where the first inequality follows because $V_{A1} > V_A(x)$ for all $x < 1$ (Assumption 1); and the second inequality follows because $V_{A1} = V_B(\widehat{x}_M)$. Moreover:

$$(V_{A1} - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}) = (V_B(\widehat{x}_M) - V_{B0}) - \widehat{x}_M(V_{B1} - V_{B0}),$$

again, because $V_{A1} = V_B(\widehat{x}_M)$. We rearrange the equation to receive:

$$V_B(\widehat{x}_M) - (\widehat{x}_M V_{B1} + (1-\widehat{x}_M)V_{B0}) = V_B(\widehat{x}_M) - (\widehat{x}_M V_B(1) + (1-\widehat{x}_M)V_B(0)) \leq$$

$$V_B(\widehat{x}_M) - V_B(1 \times \widehat{x}_M + (1-\widehat{x}_M) \times 0) = V_B(\widehat{x}_M) - V_B(1) < 0$$

where the first equality re-arranges terms and the second inequality results from the convexity of $V_B(x)$. The last inequality follows from Assumption 1. Note that the result also holds if $V_B(x)$ is linear or not too concave. Since $\widetilde{x}$ valued at the same equation is zero, and since the function is decreasing in x, it follows that $\widehat{x}_M > \widetilde{x}$. ■

Proof of Proposition 7:

When the platform that wins the group wins focality, the group joins platform B when: $xV_{B1} - p_B^G \geq xV_{A1} - p_A^G$. Then, in an equilibrium in which platform B wins, $p_A^G = -\pi_A(x;A) = -(1-x)(V_{A1} - V_{B0})$. Hence, platform B sets $p_B^G = x(V_{B1} - V_{A1}) - (1-x)(V_{A1} - V_{B0})$ and earns $\Pi_B(x;B) = \pi_B(x;B) + p_B^G = (1-x)V_{B1} + x(V_{B1} - V_{A1}) - (1-x)(V_{A1} - V_{B0}) = V_{B1} - V_{A1} + (1-x)V_{B0} > 0$, where the inequality follows because $V_{B1} > V_{A1}$ and $x \leq 1$.

Finally, to show that there is no equilibrium in which platform A wins, in this equilibrium $p_B^G = -\pi_B(x;B) = -(1-x)V_{B1}$. Hence, platform A sets $p_A^G = -x(V_{B1} - V_{A1}) - (1-x)V_{B1}$ and earns $\Pi_A(x;A) = \pi_A(x;A) + p_A^G = (1-x)(V_{A1} - V_{B0}) - x(V_{B1} - V_{A1}) - (1-x)V_{B1} = -(V_{B1} - V_{A1} + (1-x)V_{B0}) < 0$. Consequently, platform A cannot profitably win the market. ■

Proof of Proposition 8

Let f_A and f_B denote the prices that platforms A and B, respectively, charge each user inside the group. Suppose first that $x < \widehat{x}$. In the second stage, platform A always wins the individual. Therefore, in the first stage, platform B is willing to charge a user group as low as $f_B = 0$. Platform A charges each user group a price such that: $V_{A1} - f_A = V_{B0} - f_B$, or $f_A = V_{A1} - V_{B0}$. Platform A earns $xf_A + \pi_A(x;A) = V_{A1} - V_{B0}$. We need to show that A's profit from attracting both group and individual users is higher than A's profit from attracting only individual: $\pi_A(x;B) = (1-x)(V_A(1-x) - V_B(x))$. This is always the case because $V_{A1} - V_{B0} > V_A(1-x) - V_B(x)$ and $x > 0$. Therefore, there is an equilibrium in which A wins. To see that there is no equilibrium in which B wins, in such an equilibrium, A charges f_A that makes it indifferent between serving all users and earning $xf_A + \pi_A(x;A)$, or serving only individual users and earning $\pi_A(x;B)$. Solving $V_{A1} - f_A = V_{B0} - f_B$ and $xf_A + (1-x)(V_{A1} - V_{B0}) = (1-x)(V_A(1-x) - V_B(x))$ yields that B earns $\Pi_B(x;B) = xf_B = -(V_{A1} - V_{B0}) - (1-x)(V_A(1-x) - V_B(x)) < 0$, where the inequality follows because $V_{A1} > V_{B0}$ and $V_A(1-x) > V_B(x)$ whenever $x < \widehat{x}$. Hence, there is no equilibrium in which platform B wins.

Next, suppose that $x > \widehat{x}$. Consider an equilibrium in which A wins. The most B can earn when it wins the group is $f_B x + \pi_B(x;B)$), hence, the lowest price that B charges in an equilibrium in which A wins is $f_B = -\frac{\pi_B(x;B)}{x}$. Platform A sets $V_{A1} - f_A = V_{B0} - f_B$, hence, $f_A = V_{A1} - V_{B0} - \frac{(1-x)(V_B(x)-V_A(1-x))}{x}$. Let $\widetilde{\Pi}_A(x;A) = xf_A + \pi_A(x;A)$ denote the profit of platform A when group users make an individual decision and platform A wins group and individual users. We have:

$$\widetilde{\Pi}_A(x;A) = V_{A1} - V_{B0} - (1-x)(V_B(x) - V_A(1-x)). \tag{20}$$

In an equilibrium in which platform B wins, $f_A = -\frac{\pi_A(x;A)}{x}$ and $V_{A1} - f_A = V_{B0} - f_B$. Therefore, $f_B = -\frac{V_{A1}-V_{B0}}{x}$ and the profits of platform B when the group makes an individual decision, $\widetilde{\Pi}_B(x;B) = xf_B + \pi_B(x;B)$, satisfy $\widetilde{\Pi}_B(x;B) = -\widetilde{\Pi}_A(x;A)$.

Comparing $\widetilde{\Pi}_A(x;A)$ with $\Pi_A(x;A)$ from (7) yields $\widetilde{\Pi}_A(x;A) - \Pi_A(x;A) = x(V_{B1} - V_{B0}) > 0$. Using the proof of Proposition 1, we have that for $\widehat{x} < x \leq \widetilde{x}$, $\Pi_A(x;A) \geq 0$, therefore $\widetilde{\Pi}_A(x;A) > 0$, with strict inequality at $\widetilde{x}$. Because $\widetilde{\Pi}_B(x;B) = -\widetilde{\Pi}_A(x;A)$, when $\widehat{x} < x \leq \widetilde{x}$ there if no equilibrium in which B wins.

Finally, evaluated at $x = 1$, $\widetilde{\Pi}_A(1;A) = V_{A1} - V_{B0} > 0$, and again there is a unique equilibrium in which platform A wins. ■

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