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Abstract

The paper develops a static model to explore how, under platform competition, heterogeneous levels of switching costs can give rise to an incumbency advantage. The key condition required for the coexistence of both platforms on the market, to have effective competition, relies on the relative strength of switching costs over the network effects. Only when switching costs are stronger than cross-group network benefits is market tipping avoided. The same condition also underpins the presence of a material incumbency advantage vis-à-vis the entrant platform. Therefore, regulatory intervention aimed at facilitating switching, for example by imposing data portability, might worsen entry condition as the incumbent platform is less accommodative. Besides the standard configuration with exogenous singlehoming, we also fully characterise the model with endogenous multihoming on both sides. Partial multihoming occurs only on one side, the one with comparatively lower switching costs. However, in contrast to the seminal 'competition bottleneck' model, on the opposite side, where singlehoming arises endogenously, agents face higher prices than under exogenous singlehoming. Therefore, the incumbent platform would normally opt for this regime, whereas we show that the entrant is basically indifferent between the two.

Key words: two-sided markets, platform competition, switching costs, multihoming.

JEL classification: L11, L13, L4.

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1. Introduction

In many jurisdictions, governments, policy practitioners and scholars are debating whether changes to the competition rules and regulatory frameworks are needed to respond to the fact that a few digital platforms have come to play a dominant role, not only in their respective markets, but also in the wider digital sector, the economy and society at large (Schweitzer et al., 2018; OECD, 2018; Crémer et al., 2019; Furman et al., 2019; and Scott Morton et al., 2019). The early literature on the impact of network effects pointed out how they can induce 'winners-take-all' dynamics that may prevent a new platform from taking over an incumbent one, even if the former has a superior product (David, 1985; Farrell and Saloner, 1985; Katz and Shapiro, 1986; and Arthur, 1989).

Similarly, on competition among two-sided platforms, it is well understood that a new platform trying to enter a market dominated by an incumbent platform may fail to overcome the competitive disadvantage in terms of expected network size resulting from the prevailing prior belief held by agents in favour of the incumbent (Caillaud and Jullien, 2001, 2003; Hagiu 2006; and Jullien, 2011). The presence of strong cross-group network effects can strengthen this incumbency advantage (Halaburda and Yehenzkel, 2016; Biglaiser et al., 2018), even to the extent that a superior new platform might fail to enter the market as agents fail to coordinate on switching to the new platform (Halaburda et al., 2016; Halaburda and Yehenzkel, 2019). Biglaiser et al., (2019) 'define incumbency advantage as the fact that an incumbent (…) will be able to generate higher profits than a new firm (an entrant) even if the entrant offers identical terms to consumers, or even better terms (in terms of price and quality)'. These authors review recent literature on the sources of incumbency advantage due to network effects. Besides the presence of favourable beliefs, they also highlight the issue of proprietary data as a source of incumbency advantage that is, as the incumbent platform can improve its match-making algorithms due to the additional insights inferred from its vast data repository.

The resulting lack of contestability means that the incumbent platform can exert substantial market power. This outcome is partly why there are calls for regulatory interventions aimed at facilitating switching to another platform, at least in the form of partial switching, where the user remains affiliated with the current incumbent platform (i.e., multihoming).

In this respect, the presence of switching costs is considered to provide an additional source of incumbency advantage.[1] As for network effects, issues around access to user data stored by the incumbent may also give rise to switching costs, especially when data is used increasingly efficiently through algorithmic techniques, in personalising services and advertising. However, simpler issues are also at play. For example, consumers considering whether to switch to a different smartphone operating system may be worried that their data about contacts, apps or other personal data stored in the corresponding cloud service, is not easily transferrable. Similarly, e-commerce sellers considering whether to switch to a different online marketplace may be worried about portability of their historic feedback/review profile. There are circumstances where switching costs increase with network effects (Franck and Peitz, 2019), as with social media profiles where an individual identity is also made up of contributions from other related individuals belonging to the same network (i.e., 'friends'). These feedback effects can also be at play across different groups of agents: with respect to the previous example, sellers' profiles are tied to the identities of the buyers (on the opposite side of the same platform) who provided reviews and feedbacks in the past.

To address these issues, there are proposals to introduce data and identity portability in order to reduce switching costs for platform users (Gans, 2018; and Coyle, 2018).[2]

[1] This is why Farrell and Klemperer (2007) reviewed these two sources of demand-side frictions (network effects and switching costs) together.

[2] Something similar has already been implemented in the UK under Open Banking, a remedy imposed by the national competition authority to reverse the persistent low level of switching activity in the market for personal and business current accounts. The largest incumbent banks were required to adopt standardised application programme interfaces (APIs) to allow seamless access to user data (with consent) by third-party apps. One of the main functions enabled by this remedy is to send payment instructions directly from the third-party app. The aim is to unbundle the payment functionality from the core deposit-taking functionality, thus spurring more competition from non-bank payment service operators (i.e., two-sided platforms). Open Banking is also being implemented in Hong Kong from July 2018 and Australia from July 2019, with many other jurisdiction potentially following suit, including US, EU, Canada, Japan, New Zealand, India, Mexico and Singapore: see Fingleton and Open Data Institute, "Open Banking, Preparing for lift off", 16 July 2019, available at https://www.openbanking.org.uk/about-us/news/obie-launches-new-fingleton-and-odi-reportexamining-the-purpose-progress-and-potential-of-open-banking/.

Nevertheless, Franck and Peitz (2019) pointed out that switching costs may stems from the requirement, under data protection rules, to obtain consent from 'friends' to transfer the related data from one platform to another. Arguably, this impediment would still be present even with identity portability, thereby limiting the intended benefit of portability.

Notwithstanding the importance of switching costs in strengthening an incumbency advantage due to network effects,[3] the literature on the impact of switching costs on competition among two-sided platforms is scant. Lam (2017) developed a dynamic two-sided duopoly model with brand preferences à la Hotelling and homogeneous switching costs on both sides. However, in contrast to our setting, the two platforms are both symmetric incumbents. Biglaiser and Crémer (2018) develop a dynamic model where an incumbent platform faces the threat of new entry at every period and users differ in their valuation of cross-group network benefits. The authors find that the presence of users with a low valuation buttresses the incumbency advantage in that they will be the first willing to migrate to the entrant platform, but also the ones more likely to switch again in the next period to a different entrant. To the best of our knowledge, this paper provides the first attempt to model the incumbency advantage among two-sided platforms whereby agents have heterogeneous switching costs that, critically, also differ in range and average across the two platform's sides.

Given the duopolistic setting, where an incumbent platform is facing a new entrant, the assumption that agents on different sides have heterogeneous switching costs can also be used to model the existence of agents with different propensities to shop around and eventually switch. That is to say, our setting encompasses the combined presence of both search and switching costs. Issues with data and identity portability can generate

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[3] It is worth pointing out that, the European Commission included switching costs alongside network effects as a potential source for lock-in effects conferring market power to incumbent platforms: ("The interests of platforms are not always aligned with the interests of their users, which can, as a result of platforms' market power, give rise in particular to: (…) lock-in concerns (network externalities, switching costs, better service due to accessibility of data make it difficult for users to migrate to other platforms, and allow platforms to "exploit" their user bases)." EU call for contributions for the workshop "Shaping competition policy in the era of digitisation",); see also OECD (2018) at p. 77: ("Switching costs may also be important in multi-sided markets. Switching costs can create barriers to entry and expansion and, if there is a first-mover-advantage, can establish and strengthen a position of market power.")

heterogeneity to the extent that agents differ in the degree of lock-in based on data which is proprietary with the incumbent platform or tied to other users on the same platform. For example, new financial platforms are developing innovative credit scoring methodologies, mainly based on unstructured online data such as social media feeds (i.e., BigData), which are targeted at young borrowers, whereas, for older borrowers who already have a solid credit history the utility of such innovation is lower. Due to the proprietary nature of credit scoring methodologies, and thus the resulting incompatibility with other systems, there may be heterogeneous lock-in effects only affecting those consumers without an alternative source of credit history data.[4]

Another source of heterogeneity for switching costs arises when the incumbent platform provides a bundle of services while the new entrant platform only competes on a subset of those. This is the typical disruptive innovation scenario whereby the new entrant does not initially develop a fully-fledged offer, but instead focuses on a narrow scope with the strategy to broaden it as the customer base grows. Under these circumstances, users may be reliant on the incumbent platforms for other (complementary) services not offered by the new entrant to a different degree. Therefore, users choosing an entrant providing only a smaller range of services from the incumbent platform would tend to have a higher propensity to switch.[5]

Behavioural reasons have also been suggested to explain the emergence of heterogeneous switching and search costs, especially from the consumers' side of the platform.[6] For example, some consumers are early adopters in that they are more likely to try something new than more mainstream ones or, even more, late adopters who are more reluctant to change a previously chosen provider. Furthermore, these different attitudes can be related to demographic factors, where, for example, young cohorts are less invested into the incumbent platform and therefore face lower switching costs. More

[4] See, for example, John Gapper, *Alibaba's social credit rating is a risky game*, Financial Times, 21 February 2018 (paywall).

[5] Switching cost in this case may be due to transaction costs efficiencies that would be lost upon switching, or due to the presence of bundled discounts offered by the incumbent platform.

[6] Nevertheless, these sources of preference heterogeneity due to demand-side frictions can also be at play among firms, in particular with respect to small and medium enterprises, where the decision as to whether to affiliate with a new platform is often taken by the founder who may be subject to similar limitations.

generally, consumers may be more or less actively looking for a cheaper option (i.e., all else equal). Consumer inertia may be due to a default or status quo bias,[7] the so-called 'path of least resistance', whereby people opt for the easiest (i.e., less challenging) course of action which is often doing nothing at all (i.e., 'passive decision'). Arguably, this source of inertia might be particularly relevant in the context of switching to a new platform, as agents have to figure out whether the new platform will be able to attract enough mass on both sides.

Different propensities to switch may also affect the extent to which consumers benefit from the kind of remedies discussed above. For example, it may well be the case that consumers relying on data and identity portability are those more active and engaged consumers already showing a higher propensity to switch. In general, inertia may be exacerbated if agents have to learn how to use the new platform and have differing ability and/or willingness to do so.

Apart from platform-related switching costs, the other two sources of heterogeneous switching costs due to issues of data and identity portability and behavioural differences remain of relevance also when multihoming is possible. The relevance of heterogeneous switching costs is arguably being brought to the fore thanks to the adoption of advanced predictive analytics based on BigData and artificial intelligence algorithms, which allow firms to gather a more granular picture regarding consumers' propensity to shop around and search. In summary, the multifaceted nature of demand-side frictions arising from the combination of all these different sources of search and switching costs motivates the assumption that agents face heterogeneous costs.

Whilst Lam (2017) includes the presence of heterogeneous brand preferences, we depart from this, as we focus on competing mature platforms that provide essential (i.e., commoditised) match-making services whereby users show a low preference for variety (e.g., payment; e-marketplace). The combination of a lack of both quality differentiation and a sufficiently large flow of new users who have to decide which platform to join (i.e.,

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[7] For example, in its 2009 and 2018 infringement decisions against, respectively, Microsoft and Google for abuses of a dominant position, the European Commission concluded that the presence of default or status quo bias (leading to user inertia) was the key factor underpinning the persistent incumbency advantage of the Microsoft Explorer and the Google Android platforms (e.g., Fletcher, 2019; Caffarra et al., 2019).

due to the fact that demand is assumed to be saturated) tends to support the incumbency advantage (Franck and Peitz, 2019).

We model platform competition under two regimes: exogenous singlehoming, whereby agents are restricted to full-switching, in that they must leave the incumbent platform in order to join the entrant platform; and endogenous multihoming, whereby agents have the option to partially switch to the entrant platform, whilst keeping their membership with the incumbent platform. Regarding the former regime, based on asymmetric switching costs and product homogeneity, we show that the incumbent's platform will be able to set higher equilibrium prices than the entrant's one. This is because the incumbent exploits locked-in customers with high switching costs, whereas the entrant poaches those with low switching costs. Under the additional simplifying assumption of symmetric cross-group network benefits, the incumbent's prices will be higher on both sides of the platform, while both the entrant and incumbent platforms will use the difference in prices between sides to "squeeze" the less elastic side of the platform whilst subsidising the more elastic one, leading to interesting issues concerning the fairness of the resulting equilibrium allocation. Moreover, the model shows that equilibrium prices, for both the incumbent and the entrant, increase in the level of switching costs on the same side of the platform and decrease in the value of cross-platform network externalities. The analysis of the equilibrium market shares also shows that larger cross-group network benefits lead to an increase of the equilibrium incumbent's shares on both sides of the platform, a clear indication that cross-group network benefits are at the source of the incumbency advantage.

Most importantly, whilst a reduction in switching costs, perhaps resulting from regulatory intervention aimed at mandating data and identity portability, benefits consumers, it also damages the new entrant's prospect to establish a foothold in the market, as the incumbent platform becomes less accommodating. Arguably, this might in turn deter entry in the first place. This is especially the case in light of our result showing that the viability of the entrant platform rests on the existence of a sufficiently wide range of heterogeneous switching costs. It is worth noting that this would not be the result of strategic foreclosure by the incumbent platform, but merely the outcome of 'normal' (non-coordinated) competition, thus arguably not punishable under competition law. That is to say, the regulatory intervention specifically aimed at facilitating entry might unintendedly lead to the opposite outcome of entrenching market power of the incumbent platform.

Our results become more nuanced when we relax the assumption of symmetric cross-group network benefits on both sides. Surprisingly, both the incumbent's and the entrant's membership prices can fall in response to an increase in the switching costs on the same side, unless, with respect to the incumbent's price, the cross-group network benefits on the opposite side are comparatively stronger. In contrast, an increase in switching cost on the opposite side of the platform induces the entrant to lower its price whereas the incumbent does the opposite when the cross-group network benefits on the opposite side (where the increase in switching costs occurs) are comparatively weaker.

We then analyse the configuration with endogenous multihoming on both sides. We are not aware of any extant literature researching the competition outcome under endogenous multihoming on either side with heterogeneous switching costs. We show that there is a unique equilibrium configuration where multihoming takes place only on one side as a result of the incumbent strategy to maintain full coverage, so that all of the agents with low switching costs that switch to the entrant platform do so partially under multihoming. Under the simplifying assumption of symmetric cross-group network benefits, we show that this takes place on the side where the level of switching costs is comparatively lower. On the opposite side, where the level of switching cost is lower, the incumbent accommodates a singlehoming configuration by charging a higher price than under exogenous singlehoming, with the entrant following suits. Therefore, agents on this side are definitely worse-off than under the previous regime. As a result, we show that the incumbent platform would normally prefer this regime, whereas the entrant is essentially indifferent between the two configurations.

After this introduction, the rest of the paper is structured as follow: Section 2 introduces the model and derives the main propositions, while Section 3 discusses the conclusions, limitation and potential extensions of the model studied in the paper.

2. The model

In a single-period framework, an incumbent platform, I, faces the competition threat from a new entrant, E. There are two different groups of agents trading across these platforms, each group being located on a platform's opposite sides, labelled respectively: A and B. Each group is assumed to have unitary mass and we denote with $m_j^i \in [0,1]$ - with $i = I, E$,

$j = A, B$ - the masses of agents on each side that are affiliated with the incumbent's and entrant's platforms. Both platforms have no capacity constraints, they can accept any mass of users, and face the same marginal cost, f_j, to serve an additional customer on each side. For the sake of simplicity these are normalised to zero. Both groups of agents draw cross-group network benefits that are linear in the number of members on the opposite side joining the same platform, according to parameter α_j.[8] The two platforms can set different membership fees on each side, p_j^i, which, as standard in the literature, must be non-negative (e.g., Gabszewicz et al., 2001, Armstrong, 2006; and Armstrong and Wright, 2007). We assume that there is a fixed membership benefit, v, for all agents that is high enough so as to guarantee full participation on both sides.[9]

At the beginning of the period, all customers on both sides are members of the incumbent platform, I. If they want to join another platform, agents on both sides face a switching cost, s_j, with $s_j \in [0, \overline{s_j}]$ distributed according to a commonly known uniform distribution. Platforms set membership prices simultaneously. Agents know their switching cost and choose whether to switch to the entrant platform, either fully or partially.

In what follows, as a baseline scenario, we model competition under exogenous singlehoming, where customers on both sides can only choose to affiliate to one of the two platforms. Next, we consider the scenario under endogenous multihoming on both sides, and, finally, we compare these two outcomes with that observed under interoperability across the two platforms.

2.1 Exogenous singlehoming

When choosing which platform to adhere to, agents on both sides compare their utilities between staying with the incumbent platform, I, or switching to the entrant, E. Specifically, an agent on side j is indifferent between staying or switching if the net

[8] On both sides, the corresponding outside options are valued at zero. Following Armstrong (2006), and in contrast to Rochet and Tirole (2003), this parameter does not depend on which platform agents are affiliated with. This modelling assumption is in line with our focus on essential/commoditised platform services.

[9] As above, this modelling assumption is in line with our focus on essential/commoditised platform services where demand is typically saturated.

difference in cross-platform externalities and joining fees, equals a threshold switching cost s_j^*, that is:

$$v + \alpha_j m_{-j}^I - p_j^I = v + \alpha_j\left(1 - m_{-j}^I\right) - p_j^E - s_j^* \rightarrow s_j^* = \left(p_j^I - p_j^E\right) + \alpha_j\left(1 - 2m_{-j}^I\right) \quad (1)$$

Given the assumed uniform distribution of the switching costs, consumers with switching costs above this threshold, $s_j > s_j^*$ will stay with the incumbent platform I, so that the market share on side j for the incumbent, m_j^I, and the entrant, m_j^E, are respectively:

$$m_j^I = \frac{\overline{s_j} - s_j^*}{\overline{s_j}} = \frac{\overline{s_j} - \alpha_j\left(1 - 2m_{-j}^I\right) - \left(p_j^I - p_j^E\right)}{\overline{s_j}} = 1 - m_j^E \quad (2)$$

By solving the pair of above equations for m_j^I and m_{-j}^I we obtain the market shares, for both incumbent and entrant and on both sides of the platforms, in terms of the four membership prices set by the two platforms on each one of the two sides:

$$m_j^I = \frac{\overline{s_{-j}}\left(\overline{s_j} - \alpha_j + p_j^E - p_j^I\right) + 2\alpha_j\left(\overline{s_{-j}} - \alpha_{-j} + p_{-j}^E - p_{-j}^I\right)}{\overline{s_j s_{-j}} - 4\alpha_j\alpha_{-j}} = 1 - m_j^E \quad (3)$$

Given the assumption about zero costs of affiliating a new member, firms' profit functions are given by the sum of the revenues arising from the two sides: $\pi^i = \sum_j p_j^i m_j^i$. Given that prices, p_j^i, enter linearly in the determination of market shares, m_j^i, as in Eq. (3), revenues, hence profits, are quadratic in firms' prices. Hence, the two profit functions, π^i, are concave with respect to firms' prices whenever the denominator of Eq. (3), is strictly positive, or if and only if $\overline{s_j s_{-j}} - 4\alpha_j\alpha_{-j} > 0$. Intuitively, this condition requires that the demand-side frictions, captured as the product of the two maximum values for the heterogeneous switching costs, $\overline{s_j s_{-j}}$, must be larger than tipping effects, that increase, linearly, as the product of the two to cross-group network externalities, $4\alpha_j\alpha_{-j}$.[10]

Equilibrium prices and quantities, in this benchmark case, obtained by solving the system of four first order conditions for profit maximization, are given by the four price equations, p_j^i, with $j = A, B$, for the incumbent and the entrant platforms on both sides of the markets:

[10] For example, assuming that $\overline{s_j} = \overline{s}$ and $\alpha_j = \alpha$, the above condition becomes $\overline{s} > 2\alpha$. Armstrong (2006) obtained a similar condition but with respect to the 'transport' cost parameter under a Hotelling linear model of horizontal brand differentiation.

$$p_j^I = \frac{p_j^E+\alpha_j+\overline{s_j}}{2} - \frac{\alpha_{-j}\left(p_{-j}^I+\alpha_j\right)}{\overline{s_{-j}}} - \frac{\alpha_j\left(p_{-j}^I-p_{-j}^E\right)}{\overline{s_{-j}}} \quad (4.a)$$

$$p_j^E = \frac{p_j^I-\alpha_j}{2} - \frac{\alpha_{-j}\left(p_{-j}^E+\alpha_j\right)}{\overline{s_{-j}}} + \frac{\alpha_j\left(p_{-j}^I-p_{-j}^E\right)}{\overline{s_{-j}}} \quad (4.b)$$

Expressions in Eqs. (4a,b) provide useful insights. First, note that in a one-sided setting without network effects, the equilibrium prices for the incumbent and entrant platforms would be, respectively, $p_j^{I*} = \frac{2\overline{s_j}}{3}$ and $p_j^E = \frac{\overline{s_j}}{3}$, confirming that heterogeneous switching costs by themselves give rise to an incumbency advantage (as in Shaffer and Zhang, 2000). Second, the comparison of the first terms of the *RSHs* in Eqs. (4a,b) shows that the incumbent platform is able to extract the same-side cross-group network benefits, whereas the entrant must pass those on to users by discounting its prices.[11] That is to say, whilst the entrant platform also benefits from the presence of heterogeneous switching costs, albeit to a lower extent than for the incumbent, the presence of cross-group network benefits is exclusively to the advantage of the incumbent platform and, for this to be the case, there is no need for 'favourable beliefs' (i.e., as in Caillaud and Jullien, 2003). The second terms on the *RHSs* of Eqs. (4a,b) correspond to the discounting 'adjustment factor' identified by Armstrong (2006) in a model where symmetric platforms compete in membership fees and singlehoming users on both sides have horizontally differentiated preferences in the linear Hotelling fashion. The terms within brackets in the numerator of the second terms on the *RHSs* of Eqs. (4a,b) capture the marginal benefit that a platform can reap by attracting an additional user on the opposite side $-j$: besides the membership fee p_{-j}^i, the platform can extract α_j per additional side $-j$ member without triggering more switching from customers on side j.[12] Indeed these terms enter with the negative sign in the equilibrium prices, showing how additional members on side $-j$ leads to the lower price being charged on side j. The difference is that the rate at which the platform accrues new users on side $-j$ (i.e., in response to a new additional user on side j) is determined by the ratio between the cross-group network benefit parameter on side $-j$ and the corresponding switching cost parameter, rather

[11] If we ignored the second and third terms in the *RHSs*, the solutions would be $p_j^{I*} = \frac{2\overline{s_j}+\alpha_j}{3}$ and $p_j^E = \frac{\overline{s_j}-\alpha_j}{3}$.

[12] See also discussion in Belleflamme and Peitz (2019).

than the 'transport cost' as under the Hotelling framework. The third term on the *RHSs* of Eqs. (4a,b) reflects an additional adjustment factor linked to the relevance of cross-group network benefits. Specifically, the expression $\frac{\left(p^I_{-j}-p^E_{-j}\right)}{\overline{s_{-j}}}$ can be seen as an 'attrition rate', the rate at which the incumbent is bound to lose customers on side $-j$ as it typically charges a higher price than the entrant's (i.e., in line with that outlined with respect to the first term). Hence, in Eq. (4a) the term $-\frac{\alpha_j\left(p^I_{-j}-p^E_{-j}\right)}{\overline{s_{-j}}}$ represents the loss of surplus for customers on side j as the incumbent customer base on the opposite side falls due to the exploitation of lock-in effects. Whilst this adjustment factor entails a compensation for the incumbent's customers on side j (i.e., in the form of a discount off the membership price), the opposite applies with respect to the entrant.

2.1.1 Symmetric cross-group network benefits

In this section, we start by considering the simplifying assumption that cross-group network benefits are the same on both sides (i.e., $\alpha_j = \alpha$). Although this simplification might appear strong, the implications of different cross-group network benefits have been extensively explored in the early literature on two-sided platforms, and its adoption allows us to explore the full set of implications of a previously unaddressed problem, through the analysis of the model's analytical solutions. Based on this assumption, Lemma 1, below, provides the equilibrium prices, under heterogeneous switching costs and symmetric cross-group network benefits.

Lemma 1: Equilibrium prices

With symmetric cross-group network benefits and heterogeneous switching costs, the four equilibrium prices, one per side of the platform, for both incumbent and entrant are:

$$p_j^{I*} = \frac{2\overline{s_j}}{3} - \alpha \; and \; p_j^{E*} = \frac{\overline{s_j}}{3} - \alpha \qquad (5)$$

Lemma 1 shows that switching costs drive equilibrium prices. The differences in prices between incumbent and entrant, on each side, is only determined by the size of the side's switching cost, as, the difference between the equilibrium prices of the incumbent and the entrant, on each sides of the platform, $p_j^{I*} - p_j^{E*}$, is clearly equal to one third of the relevant side's switching cost: $\frac{\overline{s_j}}{3}$. Hence, we can see that Lemma1 substantiates the key role played by heterogeneous switching costs in shaping the incumbency advantage.

A second obvious implication of Lemma 1 is that both the incumbent's and the new entrant's equilibrium prices are higher on the side where switching costs are higher: that is, the difference in equilibrium prices faced by users on different sides of the same platform is solely driven by the difference in switching costs. If higher switching costs proxy customer vulnerability, this finding may raise issues concerning the fairness of the resulting equilibrium allocation. Such issues may be particularly acute if members face demographic, behavioural, informational or cognitive disadvantages that renders them less willing, or able, on average to search and switch a platform's provider.

The observation that prices increase as own-side switching costs grow larger, is consistent with the argument that heterogeneous switching costs act as a separating/partitioning device whereby the new entrant targets those agents on both sides with relatively lower switching costs, and can do so by charging higher prices as the distance from the high-cost customers targeted by the incumbent platform (on the same side) grows. This is because the equilibrium prices charged by the incumbent on both sides of the platform grow twice as fast as the same-side switching costs. As a corollary, the level of switching costs must be substantially higher than the intensity of cross-group network benefits in order for the entrant's equilibrium prices to be positive. In particular, the corresponding condition is tighter than the one presented above for the profit concavity.[13] That is to say, entry viability strongly rests on there being a sufficiently wide heterogeneity of switching costs. Accordingly, to the extent that regulatory intervention aimed at facilitating switching reduces the range of switching costs, entry might become more difficult.

Interestingly, under the assumptions of Lemma 1, equilibrium prices are not affected by the switching costs on the opposite side of the platform. Finally, it is interesting to note that all four equilibrium prices decrease in the value of cross-platform network externalities, which is assumed to be homogeneous across the two sides. This observation confirms and extends, now including heterogeneous switching costs, the standard results in the literature, whereby membership fees are discounted by the network benefits exerted on the other side of the platform.

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[13] Assuming that $\overline{s_j} = \overline{s}$ and $\alpha_j = \alpha$, the entrant's equilibrium prices are positive for $\overline{s} > 3\alpha$.

The above finding regarding the extent of the incumbent's market power is further confirmed by the results of Proposition 1, below, on the equilibrium side shares.

Proposition 1: Incumbent's side shares and switching costs

With symmetric cross-group network benefits and heterogeneous switching costs:

a) *The four market shares are given by:*

$$m_j^{I*} = \frac{2\overline{s_j s_{-j}} + \overline{s_{-j}}\alpha - 6\alpha^2}{3(\overline{s_j s_{-j}} - 4\alpha^2)} = 1 - m_j^{E*}; \quad (6)$$

b) *The incumbent, I, has a larger share on the side where switching costs are comparatively lower:* $m_j^{I*} \geq m_{-j}^{I*} \Leftrightarrow \overline{s_j} \leq \overline{s_{-j}}$ *, and vice versa with respect to the new entrant, E; and*

c) *The incumbent's side shares are always larger than those of the entrant.*

Concerning *b)*, it is not surprising that the incumbent platform's side share is comparatively smaller on the side where switching costs are higher as they are translated into higher equilibrium prices as for Lemma 1. With regards to *c)*, notwithstanding the fact that the incumbent's prices are twice as high as those charged by the entrant, the former still manages to retain a larger share on both sides. This is primarily due to the presence of heterogeneous switching costs, as even with infinitesimally small cross-group network benefits, the incumbent platform would be able to hold on to two thirds of the market.

Corollary 1

With symmetric cross-group network benefits and heterogeneous switching costs:

a) *The Incumbent's market share on side j is decreasing in the switching costs on the same side:*

$$\frac{\partial m_j^{I*}}{\partial \overline{s_j}} = -\frac{\overline{s_{-j}}\alpha(\overline{s_{-j}} + 2\alpha)}{3(\overline{s_j s_{-j}} - 4\alpha^2)^2} < 0 \quad (7a)$$

b) *The Incumbent's market share on side j is decreasing in the switching costs on the opposite side:*

$$\frac{\partial m_j^{I*}}{\partial \overline{s_{-j}}} = -\frac{2\alpha^2(\overline{s_j} + 2\alpha)}{3(\overline{s_j s_{-j}} - 4\alpha^2)^2} < 0 \quad (7b)$$

c) *The negative effect of the switching costs on side $-j$ on the incumbent's market share on side j is stronger than that on side $-j$ if: $\overline{s_{-j}} > +\sqrt{2\overline{s_j}\alpha + 5\alpha^2} - \alpha$. This threshold for $\overline{s_{-j}}$ is decreasing in both $\overline{s_j}$.*

Regarding *a)*, the analysis of equilibrium prices showed that the incumbent platform's price mark-up on switching costs is twice as high as the entrant's mark-up. Hence, it was to be expected that, in equilibrium, the incumbent's market share would fall in response to an increase in switching costs on the same side.[14] Regarding *b)*, the similar fall in the incumbent's equilibrium market share as switching costs on the opposite side rise[15] also makes intuitive sense as the shrinking share on the opposite side (i.e., due to higher corresponding prices) exerts a negative feedback loop on the current side (i.e., due to a reduction in cross-group network effects). Finally, regarding *c)*, the feedback-loop effect highlighted in *b)* is stronger than the plain-vanilla same-side effect in *a)* when the cross-group network benefits are stronger and when the degree of 'locked-in' exploitation (i.e., for high values of switching costs on the same side) is already elevated.

The set of results discussed above indicates that, in markets with strong cross-group network effects, public intervention aimed at reducing high switching costs will certainly benefit consumers. In contrast, the new entrant is squeezed as a result, as the incumbent's side shares increase (i.e., the level of switching activity shrinks), in particular on the side not being targeted by the intervention thereof. This is particularly significant from a policy perspective. The recent debate calling for stronger regulatory intervention against the incumbent platform is essentially aimed at facilitating the emergence of new platforms by making it easier for users to switch (i.e., lowering switching costs). For example, this is the main rationale underpinning the imposition of data and identity portability. Our finding shows that this type of intervention would be beneficial to consumers due to the resulting increased contestability. However, it might ultimately fail

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[14] The sign of the partial derivative of m_j^{I*} with respect to $\overline{s_j}$ is determined by the expression: $-\overline{s_{-j}}\alpha^2 - \overline{s_j s_{-j}}\alpha$. This is also always negative.

[15] The sign of the partial derivative of m_j^{I*} with respect to $\overline{s_{-j}}$ is determined by the expression: $-\overline{s_j s_{-j}}\alpha - 2\overline{s_j}\alpha^2 - 4\alpha^3$. This is always negative.

to motivate a new entrant to launch its platform, as the reduction in switching costs increases, in equilibrium, the incumbent platform's market shares.

Next, we focus on the effects of cross-group network benefits on the incumbent's side shares.

Corollary 2: Incumbent's market shares and cross-group network benefit

With symmetric cross-group network benefits and heterogeneous switching costs:

a) The incumbent's market shares on both sides increase in the cross-group network benefits:

$$\frac{\partial m_j^{I*}}{\partial \alpha} = \frac{\overline{s_{-j}}\left(\overline{s_j s_{-j}} + 4\alpha\left(\overline{s_j} + \alpha\right)\right)}{3\left(\overline{s_j s_{-j}} - 4\alpha^2\right)^2} > 0 \tag{8}$$

b) The positive impact of the cross-group network benefits on the incumbent's market shares is larger on the side where the switching costs are lower and vice-versa.

Point *a)* confirms that role of cross-group network benefits as source of the incumbency advantage. Concerning *b)*, the difference of these two effects is given by: $\left(\overline{s_j} - \overline{s_{-j}}\right)\left(4\alpha^2 + \frac{\overline{s_{-j}}}{\overline{s_j}}\right)$. Hence, if switching costs are higher on the *j* side, $\overline{s_j} > \overline{s_{-j}}$, the impact on the incumbent's side share of increased cross-group network benefits is stronger on the opposite side, and vice-versa. This is interesting as it shows how asymmetric switching costs helping leveraging the incumbency advantage arising from cross-group network benefits on the side where the switching costs are lower.

In summary, the presence of heterogeneous switching costs, often generated by behavioural inertia, gives rise to an incumbency advantage. Indeed, the incumbent profits are always higher (i.e., as it charges higher prices over a larger customer base), as confirmed by following expressions for the incumbent's and entrant's equilibrium profits:

$$\pi^{I*} = \frac{\left(\overline{s_j} + \overline{s_{-j}}\right)\left(4\overline{s_j s_{-j}} - 15\alpha^2\right) - 4\alpha\left(2\overline{s_j s_{-j}} - 9\alpha^2\right)}{9\left(\overline{s_j s_{-j}} - 4\alpha^2\right)} \tag{9a}$$

$$\pi^{E*} = \frac{\left(\overline{s_j} + \overline{s_{-j}}\right)\left(\overline{s_j s_{-j}} - 3\alpha^2\right) - 4\alpha\left(2\overline{s_j s_{-j}} - 9\alpha^2\right)}{9\left(\overline{s_j s_{-j}} - 4\alpha^2\right)} \tag{9b}$$

$$\Delta\pi = \pi^{I*} - \pi^{E*} = \frac{\overline{s_j} + \overline{s_{-j}}}{3} > 0 \tag{9c}$$

Nevertheless, the coexistence of both platforms requires a preponderance of switching costs over cross-group network benefits in order to avert 'tipping'. This condition underpins the presence of the incumbency advantage (9c) that is not mitigated by regulatory interventions aimed at reducing switching costs.

However, regulatory intervention could prove effective if it were to generate the heterogeneous distribution of switching costs to start with. This could be the case if, absent the intervention, switching costs remain uniformly high across the board. Under these counterfactual circumstances, switching costs would unambiguously attribute a cost advantage to the incumbent. Under Bertrand competition, and in the absence of any other source of preference heterogeneity such as under horizontal product differentiation, all agents would hold the same preference regarding which platform maximises utility. Therefore, as highlighted in the early literature on platform competition, entry deterrence may be the result of insurmountable unfavourable beliefs regarding the expected network size of the new entrant's platform.

Perhaps counterintuitively, if regulatory intervention reduces switching costs similarly across the board, thus preserving preference homogeneity, entry deterrence might still prevail given the persistent 'winner-takes-all' nature of competition *for* the market. In contrast, if users differ in the way they benefit from regulatory intervention, the ensuing preference heterogeneity may support entry.[16] This is the case if, for example, users differ in the way they take advantage of data and identity portability (i.e., early/active vs late/inactive adopters/users). Ultimately, once the new entrant reaches an established foothold in terms of platform size, it would be better placed to compete head-to-head against the incumbent platform due to the uniformly reduced switching costs (i.e., as data and identity portability is taken up also by late/inactive adopters/users).

2.1.2 Asymmetric cross-group network benefits

In order to further explore the nature of the interaction between switching costs and cross-group platform externalities, in this section we consider the more general case when cross-group network can differ between the two sides ($\alpha_j \neq \alpha_{-j}$).

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[16] However, if the reduction of switching costs lowers the maximum levels so much that the profit concavity condition no longer holds, entry might be nevertheless deterred as 'tipping effects' are resumed.

Lemma 2: Equilibrium Prices

With asymmetric cross-group network benefits and heterogeneous switching costs, the four equilibrium prices, one per side of the platform, for both incumbent and entrant are:

$$p_j^{I*} = \frac{\overline{s_j s_{-j}}(6\overline{s_j} - 10\alpha_{-j} + \alpha_j) + 2(\alpha_{-j} + 2\alpha_j)[2\alpha_{-j}(2\alpha_{-j} + \alpha_j) - \overline{s_{-i}}(3\alpha_{-j} + \alpha_j)]}{9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})} \tag{10a}$$

$$p_j^{E*} = \frac{\overline{s_j s_{-j}}(3\overline{s_j} - 8\alpha_{-j} - \alpha_j) - 2(\alpha_{-j} + 2\alpha_j)[\overline{s_j}(\alpha_{-j} + \alpha_j) - 2\alpha_{-j}(2\alpha_{-j} + \alpha_j)]}{9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})} \tag{10b}$$

The first interesting result, arising from this more general setting that allows for asymmetric cross-group network benefits, is that, similarly to the simpler configuration with symmetric cross-group network benefits, the incumbent platform sets higher prices than the entrant platform on both sides for a relevant set of parameter values (i.e., $p_j^{I*} \geq p_j^{E*}$).[17] Moreover, as shown below, in Proposition 2, over a plausible set of parameters, both the incumbent's and the entrant's equilibrium prices increase as the level of the same-side switching costs increases.

Proposition 2: Prices and same-side switching costs

With asymmetric cross-group network benefits and heterogeneous switching costs:

a) *The incumbent's price on side j increases when switching costs on the same side increase if:*

$$\frac{\delta p_j^{I*}}{\delta \overline{s_j}} = \frac{6(3\overline{s_j s_{-j}})^2 + 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})[2(\alpha_{-j} + 2\alpha_j)(3\alpha_{-j} + \alpha_j) - \overline{s_{-j}}(12\overline{s_j} - \alpha_{-j} + \alpha_j)]}{[9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})]^2} \geq 0 \tag{11a}$$

b) *The entrant's price on side j increases when switching costs on the same side increase if:*

$$\frac{\delta p_j^{E*}}{\delta \overline{s_j}} = \frac{3(3\overline{s_j s_{-j}})^2 + 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})[2(2\alpha_{-j} + \alpha_j)(\alpha_{-j} + \alpha_j) - \overline{s_{-j}}(6\overline{s_j} - \alpha_{-j} + \alpha_j)]}{[9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})]^2} \geq 0 \tag{11b}$$

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[17] Specifically, the price difference, $p_j^{I*} - p_{-i}^{E*}$, is given by: $\frac{\overline{s_j}[\overline{s_{-j}}(3\overline{s_j} + 2(\alpha_j - \alpha_{-j})) - 4\alpha_{-j}(2\alpha_j + \alpha_{-j})]}{9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})}$. This is positive for: $\alpha_j > \frac{-3\overline{s_j s_{-j}} + 2\overline{s_{-j}}\alpha_{-j} + 4\alpha_{-j}^2}{2(\overline{s_{-j}} - 4\alpha_{-j})}$, which should hold as the numerator (denominator) is normally negative (positive) over the range of parameters that guarantees the existence of interior solutions (i.e., $\overline{s_j s_{-j}} - 4\alpha_j\alpha_{-j} \geq 0$).

c) *Both these conditions in a) and b) are almost certainly satisfied over the range of parameters that guarantees the existence of interior solutions (i.e.,* $\overline{s_j s_{-j}} - 4\alpha_j\alpha_{-j} \geq 0$*).*

Regarding the condition in *a)*, it is helpful to simplify the numerator on the *RHS* in Eq. (11a) as in the previous case when cross-group network benefits are symmetric (i.e., $\alpha_j = \alpha, j = A, B$). In this simplified case, the numerator of the *RHS* in Eq. (11a) becomes: $6\left(3\overline{s_j s_{-j}}\right)^2 + 4(3\alpha)^2(24\alpha^2 - 12\overline{s_j s_{-j}})$. It is easy to check that this expression goes to zero as $\overline{s_j s_{-j}} = 4\alpha^2$, and is positive for $\overline{s_j s_{-j}} > 4\alpha^2$. The same applies to the numerator of the *RHS* in Eq. (11b). First, it makes intuitive sense that, as the preponderance of switching costs falls up to the point where tipping effects are resumed, both platforms do not raise prices in response to an increase in switching costs. With asymmetric cross-group network benefits, for this condition not to hold over the relevant set of parameters there must be a combination of comparatively low levels of switching costs (i.e., close to satisfy $\overline{s_j s_{-j}} = 4\alpha_j\alpha_{-j}$) and stronger cross-group network benefits on side $-j$ ($\alpha_{-j} > \alpha_j$). This too makes intuitive sense, given that, all else equal, the market share on side $-j$ falls because of a corresponding price increase on the same side. This, in turn, hurts the firm in question on the opposite side, given that those users care more about the ensuing loss of cross-group network benefits.

Next, we investigate how equilibrium prices react to increases of opposite side's switching costs.

Proposition 3: Prices and opposite side switching costs

With asymmetric cross-group network benefits and heterogeneous switching costs

a) *The incumbent's price on side j increases when the switching costs for the opposite side increase if and only if* $\alpha_{-j} \geq \alpha_j$*, since:*

$$\frac{\delta p_j^{I*}}{\delta \overline{s_{-j}}} = \frac{2\overline{s_j}(\alpha_{-j}-\alpha_j)(\alpha_{-j}+2\alpha_j)(3\overline{s_j}+4\alpha_{-j}+2\alpha_i)}{\left[4(2\alpha_j+\alpha_{-j})(\alpha_j+2\alpha_{-j})-9\overline{s_j s_{-j}}\right]^2} \tag{12a}$$

b) *The entrant's price on side j decreases when the switching costs on the opposite side increase if and only if* $\alpha_{-j} \geq \alpha_j$*, since:*

$$\frac{\delta p_j^{E*}}{\delta \overline{s_{-j}}} = -\frac{2\overline{s_j}(\alpha_{-j}-\alpha_j)(\alpha_{-j}+2\alpha_j)(3\overline{s_j}+4\alpha_{-j}+2\alpha_i)}{\left[4(2\alpha_j+\alpha_{-j})(\alpha_j+2\alpha_{-j})-9\overline{s_j s_{-j}}\right]^2} \tag{12b}$$

That is to say, that *if* $\alpha_{-j} \geq \alpha_j$ the entrant's prices move in opposite directions in response to changes in switching costs on the opposite side, while the incumbent's ones move in the same direction

Focussing on the price effects, one may notice that Proposition 3's results are in contrast to those of Lemma 1, obtained under the simpler configuration with symmetric cross-group network benefits where a change in the switching costs on one side had no effect on the level of prices on the opposite site.

Moreover, Proposition 3, shows that the incumbent's and entrant's prices change at the opposite rate, when switching costs on the opposite sides increase. Hence, we can see that: with asymmetric cross-group network benefits and heterogeneous switching costs, the price gap, and hence the incumbency advantage, increases when switching costs on the opposite side decline and $\alpha_{-j} \geq \alpha_j$.

As set out in Proposition 2, an increase in switching costs on side $-j$ leads both platforms to increase same-side prices (i.e., driven by the exploitation of lock-in effects by the incumbent). However, as shown in *Corollary 3* (below), the incumbent's share on side $-j$ will fall as a result. The pricing reactions by rival platforms on the opposite side depend on which side cares more about cross-group network benefits. With respect to the entrant, when $\alpha_{-j} > \alpha_j$, customers on side $-j$ are more responsive to changes in the number of members on the opposite side. When their customers' switching costs increase, the new entrant must find a way to compensate for this in order to entice them back. To this end, the new entrant lowers the price charged on the opposite side in order to increase adoption on that side and thus the cross-side network benefits enjoyed by customers on side $-j$ who decide to switch. This response is arguably more efficient than cutting the increase in price on side $-j$ (i.e., the entrant's best response to the incumbent's price increase on side $-j$ is to follow suit, as with strategic complement). When side j is the more responsive to the cross network benefits, when $\alpha_j > \alpha_{-j}$, the entrant platform can exploit the fact that its share on the opposite side increases as a result of more intense exploitation of 'locked-in' customers by the incumbent. Hence, the entrant increases the price on side j. Opposite lines of argument apply to the incumbent platform. When customers on side j are more responsive to the cross network benefits, when $\alpha_j > \alpha_{-j}$, the reduction in the share on the opposite side induces the incumbent to lower prices on side j to compensate customers for the loss of cross-group network benefits. In contrast, when $\alpha_{-j} > \alpha_j$, the incumbent is less concerned about the negative feedback loop and thus increases prices on side j. In summary, Proposition 3 shows that rivals' prices are in a relation of strategic substitutability in response to an increase in switching costs on the opposite side.

In light of these observations, regulatory intervention aimed at lowering switching costs, say, on side $-j$, would have opposite impacts on users on the opposite side depending on their level of switching costs (i.e., assuming there is switching cost heterogeneity post intervention). When users on side j care more about cross-group network benefits ($\alpha_j > \alpha_{-j}$), the entrant must compensate those users with a higher propensity to switch for the loss of cross-group network benefits (i.e., as the incumbent market share on side $-j$ increases in response to lower same-side prices) by lowering its same-side price. In contrast, the incumbent can capitalise on the resulting market share increase on side $-j$ by increasing its price on side j targeted at high switching-costs customers. When the more responsive side is $-j$ ($\alpha_{-j} > \alpha_j$), the incumbent platform has to lower the price on side j to increase that market share, to retain customers on the opposite side who find it easier to switch. At the same time, the entrant finds it more efficient to poach users on side $-j$ by lowering its price, rather than boosting its cross-group network benefits by lowering the price on the opposite side to increase that market share. The following table summarises these results.

Table 1: Summary of price effects in response to changes in switching costs on the opposite side

$\overline{s_{-j}}$ ↑	$\alpha_{-j} > \alpha_j$	$\alpha_j > \alpha_{-j}$
δp_j^{I*}	↑ incumbent can still retain side $-j$ customers notwithstanding worse network benefits due to lower m_j^{I*}	↓ incumbent must compensate side j users for loss of network benefits due to lower m_{-j}^{I*}
δp_j^{E*}	↓ entrant must increase m_j^{E*} to poach side $-j$ users by improving their network benefits	↑ entrant can capitalise on higher network benefits for side j users thanks to higher m_{-j}^{E*}

$\overline{s_{-j}}$ ↓	$\alpha_{-j} > \alpha_j$	$\alpha_j > \alpha_{-j}$

δp_j^{I*}	↓ incumbent must increase m_j^{I*} to retain side $-j$ customers by improving their network benefits	↑ incumbent can capitalise on higher network benefits side j users thanks to higher m_{-j}^{I*}
δp_j^{E*}	↑ entrant can still poach side $-j$ users notwithstanding worse network benefits due to lower m_{-j}^{E*}	↓ entrant must compensate side j users for loss of network benefits due to lower m_{-j}^{E*}

The following proposition deals with the equilibrium side shares.

Proposition 4: Market concentration and switching costs

With asymmetric cross-group network benefits and heterogeneous switching costs:

a) *Incumbent's and entrant's market shares are given by:*

$$m_j^{I*} = \frac{6\overline{s_j s_{-j}} + (\alpha_j + 2\alpha_{-j})[\overline{s_{-j}} - 2(2\alpha_j + \alpha_{-j})]}{9\overline{s_j s_{-j}} - 4(2\alpha_j + \alpha_{-j})(\alpha_j + 2\alpha_{-j})} = 1 - m_j^{E*} \tag{13}$$

b) *The incumbent, I, has a larger share on the side where switching costs are comparatively lower:* $m_j^{I*} \geq m_{-j}^{I*} \Leftrightarrow \overline{s_j} \leq \overline{s_{-j}} \frac{\alpha_j + 2\alpha_{-j}}{2\alpha_j + \alpha_{-j}}$, *and vice versa with respect to the new entrant; and*
c) *The incumbent's market shares are always larger than those of the entrant.*

Regarding *b)*, the condition on the switching costs is similar to the corresponding one under the simpler configuration with symmetric cross-group network benefits (see *Proposition 1(b)*), but for the appearance of the multiplier factor: $\frac{\alpha_j + 2\alpha_{-j}}{2\alpha_j + \alpha_{-j}}$. When $\alpha_{-j} < \alpha_j$ the incumbent's market share on side j would be larger than on the opposite side even with symmetric switching costs (i.e., $\overline{s_j} = \overline{s_{-j}}$). This makes intuitive sense, as the ability to exploit lock-in effects is weaker over the side opposite to where consumers care more about cross-group network.

Next, let us investigate how equilibrium market shares vary in response to changes in the levels of switching costs on either side.

Corollary 3: incumbent's market shares and switching costs

With asymmetric cross-group network benefits and heterogeneous switching costs:

a) *The Incumbent's share on side j is decreasing in the switching costs on the same side:*

$$\frac{\partial m_j^{I*}}{\partial \overline{s_j}} = -\frac{3\overline{s_{-j}}(\alpha_j+2\alpha_{-j})(3\overline{s_{-j}}+4\alpha_j+2\alpha_{-j})}{(4(2\alpha_j+\alpha_{-j})(\alpha_j+2\alpha_{-j})-9\overline{s_j s_{-j}})^2} < 0 \tag{14a}$$

b) *The Incumbent's share on side j is decreasing in the switching costs on the opposite side:*

$$\frac{\partial m_j^{I*}}{\partial \overline{s_{-j}}} = -\frac{2(3\overline{s_j}+2\alpha_j+4\alpha_{-j})(2\alpha_j+\alpha_{-j})(\alpha_j+2\alpha_{-j})}{(9\overline{s_j s_{-j}}+4(2\alpha_j+\alpha_{-j})(\alpha_j+2\alpha_{-j})-9\overline{s_j s_{-j}})^2} < 0 \tag{14b}$$

Point *a)* replicates the corresponding finding under the simpler configuration. Regarding *b)*, this is consistent with the price effects under $\alpha_{-j} > \alpha_j$ discussed above, whereby the entrant must improve cross-group network benefits for users subject to higher switching costs. However, the finding that the incumbent's market share on side *j* also falls when same-side users are more responsive to the fall in its share on the opposite side indicates that, in equilibrium, the incumbent decides to compensate side *j* users for the reduction in cross-group network benefits only partially. Finally, from a policy perspective, both results are consistent with the observation made under the simpler configuration with symmetric cross-group network benefit, that regulatory intervention aimed at facilitating entry by lowering switching costs might deter entry due to resulting the fall in shares in response to the more aggressive stance by the incumbent platform.

2.2 Endogenous multihoming

In the vast majority of the literature on competition between two-sided platforms, agents' choices are exogenously confined to either singlehoming or multihoming. The literature researching the competition outcome under endogenous multihoming is relatively limited. Rochet and Tirole (2003), for example, analysed endogenous multihoming when platforms only charge transaction fees on both sides. Users on both sides differ in the intensity of cross-group network benefits. In addition, users on only one have heterogeneous preferences with respect to platform membership (i.e, typically the buyers' side, whereas sellers perceive platforms as undifferentiated). Liu et al. (2019) extends the Rochet and Tirole (2003) model beyond the duopolistic setting by comparing a benchmark configuration where only one side can multihome (i.e., typically the sellers' side) with one where this option is available on both sides. Their main result is that extending multihoming to the buyers' side raises their transaction fee and lowers the one for sellers. This is because the bargaining power of sellers is strengthened, as they can choose which platform to use to reach a multihoming buyer. In turn, the incentive to compete to sign-up (previously singlehoming) buyers is weakened. Armstrong and Wright (2007) extend the Armstrong (2006) symmetric duopolistic model to show that when horizontal differentiation is strong (i.e., compared to cross-group network effects), users on both sides choose singlehoming. In addition, the authors analyse the 'competitive bottleneck' model, also developed in Armstrong (2006), where there is horizontal differentiation only on one side, whereas on the other side demand is frictionless. Under this setting, there can be an equilibrium where agents singlehome on the differentiated side and multihome on the undifferentiated side, with the latter set of users facing monopolistic membership fees to access singlehoming users on the differentiated side. Jeitschko and Tremblay (2018) extend Armstrong (2006)'s symmetric framework with horizontal differentiation on both sides by introducing an additional stand-alone benefit over the traditional cross-group network benefits, which provides a motivation for multihoming unrelated to network size.[18] The main finding is that when cross-group network benefits are strong enough, there can exist equilibria with a mix of multihoming and singlehoming on both sides of the platforms. Belleflamme and Peitz (2019) extend Armstrong (2006)'s asymmetric competition bottleneck framework by also introducing an additional stand-alone benefit over the traditional cross-group network benefits. The authors compare this configuration with one where both sides exogenously singlehome and one where platforms can impose exclusivities on the multihoming side. They find that it is not possible a priori to say whether the multihoming side benefits or suffers compared to the singlehoming benchmark. Interestingly, they show that there can be situations where the multihoming side may benefit and the singlehoming side suffer, in contrast to the standard 'competitive bottleneck' outcome. In our setting, further developed below, there is no incremental fixed additional membership benefit upon joining a second platform (as in Armstrong and Wright, 2007). We are not aware of any extant literature researching the competition outcome under endogenous multihoming on either side with heterogeneous switching costs.

[18] See also Belleflamme and Peitz (2018, Section 4.3.3).

Under endogenous multihoming, all agents, initially affiliated with the incumbent platform, have three options to choose from: *i)* stay with firm I; *ii)* switch to firm E; and *iii)* opt for multihoming.[19] The corresponding utilities are as follows:

$$\text{i.} \qquad v + \alpha_j\left(m_{sh,-j}^{I} + m_{mh,-j}\right) - p_j^{I} \tag{15a}$$

$$\text{ii.} \qquad v + \alpha_j\left(1 - m_{sh,-j}^{I}\right) - p_j^{E} - s_j \tag{15b}$$

$$\text{iii.} \qquad v + \alpha_j - p_j^{E} - p_j^{I} - s_j \tag{15c}$$

where $m_{sh,-j}^{I}$ is incumbent's share of agents on side $-j$ who opted for singlehoming (i.e., because they have high switching costs) and $m_{mh,-j}$ is the share of agents on side $-j$ who opted for multihoming, thus choosing to pay for the membership of both the incumbent and the entrant's platforms. It is easy to see how the comparison of the payoffs for the last two options (15b) and (15c) is not affected by the, heterogeneous, values of the agents' switching costs, s_j. That is, regardless of the fact that they have different levels of switching costs, when comparing the decisions between switching by singlehoming with the entrant or by multihoming, all agents will opt for the same option, independently of the specific value of their switching cots. They will all choose, between these two options (15b) and (15c), the one that delivers the higher level of utility (i.e., à la Bertrand).

Therefore, for multihoming to be the dominant option over singlehoming with the entrant, the incumbent price, p_j^{I}, must be low enough to satisfy the choice constraint:

$$p_j^{I} \leq \alpha_j m_{sh,-j}^{I} \tag{16}$$

In words, the incumbent's price on side j needs to be no larger than the net benefits from the cross-group network benefits derived from being able to reach, due to multihoming, its members on the opposite side $-j$ who stick to singlehoming (i.e., because of higher levels of switching costs). Under these circumstances, any agent that decides to be a member of the entrant platform, E, would also be a member of the incumbent one, having opted for multihoming, that is, as the decision to also keep the

[19] It could be argued that under multihoming agents face comparatively lower switching costs, due to the fact that they keep the current membership active (i.e., partial switching). Nevertheless, agents would still face a combination of search and switching costs. In particular, regarding the latter, issues due to lack of data portability would still negatively affect the level of utility that agents could extract from the second membership.

membership with the incumbent platform would deliver a positive net utility for everyone, regardless of the specific levels of switching costs.

Accordingly, agents on the opposite side $-j$ have three options available to them: *i)* stay with firm I; *ii)* switch to firm E; and *iii)* opt for multihoming. Corresponding utilities are as follows:

i. $v + \alpha_{-j} - p^{I}_{-j}$ (17a)

ii. $v + \alpha_{-j}(1 - m^{I}_{sh,j}) - p^{E}_{-j} - s_{-j}$ (17b)

iii. $v + \alpha_{-j} - p^{E}_{-j} - p^{I}_{-j} - s_{-j}$ (17c)

Firstly, membership with the incumbent platform delivers the maximum level of cross-group network benefits due to the fact that all agents on side *j* keep their affiliation. By the same token, the multihoming option *iii)* is always dominated by option *i)* to just stay with the incumbent platform. Hence, in equilibrium, the option of multihoming may be adopted only on one side of the platform. Therefore, the indifferent user on side $-j$ can be identified by equalising the utilities under the two singlehoming options and solving for the critical level of switching costs, which gives: $s^{*}_{-j} = (p^{I}_{-j} - p^{E}_{-j}) - \alpha_{-j}(m^{I}_{sh,j})$.

The next step, to define the incentive towards multihoming, is to identify the indifferent user on side *j* by equalising the utility under singlehoming with the incumbent platform with the one under multihoming, both conditional on $p^{I}_{j} = \alpha_j m^{I}_{sh,-j}$, which gives: $s^{*}_{j} = \alpha_j(1 - m^{I}_{sh,-j}) - p^{E}_{j}$.[20]

Neither the incumbent nor the entrant has an incentive to deviate from this configuration. Regarding the incumbent, in setting the membership fee on side – *j*, it faces a trade-off between exploiting lock-in effects with respect to agents with high switching costs and squeezing the (singlehoming) membership base of the entrant so as to raise the membership fee on the opposite side j (i.e., $p^{I}_{j} = \alpha_j(1 - m^{E}_{sh,-j})$. The incumbent could instead replicate the cornering strategy adopted on side *j*. This would in turn erase the membership base of the entrant on side *j*, as the multihoming option on that side would also be dominated by the singlehoming option with the incumbent platform. Such a strategy would amount to entry deterrence. Nevertheless, the analysis presented in the

[20] The expression would be $s^{*}_{j} = \alpha_j(1 - m^{I}_{\mathrm{sh},-j} - m_{mh,-j}) - p^{E}_{j}$, but we have just shown that $m_{mh,-j} = 0$.

previous section under singlehoming showed that such an aggressive strategy would not be optimal, given the assumption about the relative preponderance of switching costs over cross-group network benefits ($\overline{s_j s_{-j}} - 4\alpha_j\alpha_{-j} > 0$), such that 'tipping' equilibria are averted. Hence, we can rule out the pre-emptive strategy to undercut the new entrant on both sides.

The entrant platform cannot resist this strategy by, specifically, trying to reach universal coverage on side $-j$, that is, as the incumbent exploits its 'locked-in' customers. This is because, thanks to universal incumbent's membership on side j, users affiliated with the incumbent platform on side $-j$ with high switching costs cannot be induced to switch, not even partially (i.e., multihoming), that is, unless the entrant platforms compensate them for the switching costs that would be incurred upon switching.[21] In any case, this strategy profile is included in the above configuration as a corner solution. Alternatively, the entrant could seek to achieve universal coverage on side j, by pursuing universal multihoming adoption on that side, which would allow in turn to set a higher membership fee on the opposite side. However, as before, the entrant would have to compensate for increasingly high levels of switching cost. Again, this strategy profile is included in the above configuration as a corner solution. Finally, the entrant could adopt an aggressive strategy by seeking to achieve full coverage on both sides, thus rendering the continued membership with the incumbent platform valueless. However, as for the incumbent, the analysis presented in the previous section showed that that such an aggressive strategy would not be optimal and that platforms would instead prefer to share the market under a singlehoming equilibrium. This also implies that for the configuration described above to be an equilibrium, it must be the case that the profit for the incumbent is higher than under singlehoming, given that it is up to the incumbent to decide whether to subsidise multihoming on, say, side j. The following proposition summarises these findings.

Proposition 5: Possible equilibrium configurations under endogenous multihoming

[21] For example, to lure the incumbent's customer with the highest level of switching cost the entrant would have to set $p^E_{-j} = p^I_{-j} - \alpha_{-j}(m^I_{sh,j}) - \overline{s_{-j}}$.

Besides the singlehoming equilibrium, under endogenous multihoming the only alternative possible configuration is to have (partial) multihoming only on one side and singlehoming on the opposite side. On the side with multihoming, every agent is a member of the incumbent platform. In addition, the incumbent platform can select which of the two configurations to adopt, whereas the entrant platform can only passively adapt to the incumbent's choice.

Accordingly, the only alternative strategy to the equilibrium under singlehoming would be for the incumbent platform to maintain universal coverage on, say, side j in order to charge more to singlehoming users (i.e. those with high-switching costs) on, say, side $-j$. The expressions for the four side shares are:[22]

$$m_j^I = 1, m_j^E = \frac{\alpha_j\left(1-m_{-j}^I\right)-p_j^E}{\overline{s_j}} \text{ and } m_{-j}^I = \frac{\overline{s_{-j}}-\left(p_{-j}^I-p_{-j}^E\right)+\alpha_{-j}\left(1-m_j^E\right)}{\overline{s_{-j}}} = 1 - m_{-j}^E \quad (18)$$

Substituting the expression for m_j^E into the one for m_{-j}^I and rearranging gives:

$$m_{-j}^I = 1 - \frac{\overline{s_j}(p_{-j}^I-p_{-j}^E)-\alpha_{-j}(\overline{s_j}-p_j^E)}{\overline{s_j s_{-j}}-\alpha_j\alpha_{-j}} \quad (19)$$

This expression can be substituted into the following firms' profit equations:

$$\pi^I = \left(\alpha_j + p_{-j}^I\right)m_{-j}^I \text{ and } \pi^E = (1-m_{-j}^I)\left(\frac{\alpha_j p_j^E}{\overline{s_j}} + p_{-j}^E\right) - \frac{{p_j^E}^2}{\overline{s_j}} \quad (20)$$

The solutions for prices and quantities can be found by solving the system of three first order conditions for profit maximization with respect to p_{-j}^I, p_{-j}^E and p_j^E:

$$p_{-j}^I = \frac{p_{-j}^E+\alpha_{-j}+\overline{s_{-j}}-\alpha_j}{2} + \frac{\alpha_{-j}(p_j^E-\alpha_j)}{2\overline{s_j}} \quad (21a)$$

$$p_{-j}^E = \frac{p_{-j}^I-\alpha_{-j}}{2} - \frac{p_j^E(\alpha_j+\alpha_{-j})}{2\overline{s_j}} \quad (21b)$$

$$p_j^E = \frac{\alpha_j\left(p_{-j}^I-p_{-j}^E\right)-\alpha_{-j}\left(p_{-j}^E+\alpha_j\right)}{2\overline{s_{-j}}} \quad (21c)$$

It is worth noting that the profit concavity condition with respect to these three prices is: $\overline{s_j s_{-j}} - \alpha_j\alpha_{-j} > 0$.[23] This is far less stringent than the one under singlehoming. That is to say, the extent of switching costs' preponderance over cross-group network

[22] To simplify notations, in what follows we drop the subscript sh.

[23] Specifically, $\frac{\partial \pi^i}{\partial {p_{-j}^i}^2} = -\frac{2\overline{s_j}}{\overline{s_j s_{-j}}-\alpha_j\alpha_{-j}}$ and $\frac{\partial \pi^E}{\partial {p_j^E}^2} = -\frac{2\overline{s_{-j}}}{\overline{s_j s_{-j}}-\alpha_j\alpha_{-j}}$.

benefits required to avert tipping ('winner-takes-all') outcomes is less demanding than under singlehoming. This makes intuitive sense.

In addition, it is interesting to compare these expressions with the analogous ones under the singlehoming configuration of Eqs. (4a,b). First, the first RHS terms in Eqs (21a,b) are very similar to the corresponding ones under singlehoming, reflecting the fact that firms pursue singlehoming strategies on side $-j$. Secondly, Eq. (21c) corresponds to the second and third *RHS* terms in Eq. (4a): that is, two adjustment factors driven by the presence of cross-group network benefits. The absence of the first *RHS* term reflects the fact that the entrant's pricing stance on side j is under pressure due to the cornering strategy adopted by the incumbent platform.

2.2.1 Symmetric cross-group network benefits

As in section 2.1.1, in this section we develop the basic intuition under a simpler configuration by assuming that the cross-group network benefit parameters are the same on both sides (i.e., $\alpha_j = \alpha, j = A, B$).

Lemma 3: Prices and market shares under the multihoming configuration

With asymmetric cross-group network benefits and heterogeneous switching costs, under the multihoming configuration the four prices and market shares, one per side of the platform, for both incumbent and entrant are:

$$p_j^{I*} = \alpha m_{-j}^{I*} \text{ and } p_{-j}^{I*} = \frac{2\overline{s_{-j}} - \alpha}{3} - \frac{2\alpha^2}{3\overline{s_j}} \quad (22a)$$

$$p_j^{E*} = 0 \text{ and } p_{-j}^{E*} = \frac{\overline{s_{-j}} - 2\alpha}{3} - \frac{\alpha^2}{3\overline{s_j}} \quad (22b)$$

$$m_j^{I*} = 1,\ m_{-j}^{I*} = \frac{2}{3} + \frac{2\overline{s_j}\alpha}{3(\overline{s_j s_{-j}} - \alpha^2)} = 1 - m_{-j}^{E*},\ \text{and } m_j^{E*} = \frac{\alpha}{\overline{s_j}} m_{-j}^{E*} \quad (22c)$$

These conditions offer a number of insights. First, as in the previous configuration under exogenous singlehoming (see Eq. 5), the incumbent's price on side $-j$ (i.e., with endogenous singlehoming) increases by twice as much as for the entrant's in response to an increase in switching costs on the same side. Second, in contrast to the previous configuration, prices on side $-j$ depend also on the level of switching costs on the opposite side, and, specifically, increase as the latter increases. Third, the condition for prices on side $-j$ to be both positive tends to be stricter than the profit concavity condition under exogenous singlehoming, but less so with respect to the condition for positive entrant's equilibrium prices under singlehoming.[24] Given that the entrant's price on side j is zero, this condition essentially determines whether entry is viable. Therefore, the regime under (exogenous) singlehoming tends to be less accommodative, in terms of viability for the entrant platform, than under (endogenous) multihoming. This finding is important, given that policy makers attribute great importance to the option for users to be able to multihome: that is, any attempt by the incumbent platforms to forestall multihoming is likely to be scrutinised by competition authorities.[25]

Finally, both prices on side $-j$ under this configuration are higher than under the previous one if and only if the level of switching costs on the opposite side, where there is multihoming, is higher than the symmetric cross-group network benefit parameter (i.e., $\overline{s_j} > \alpha$), which is normally the case within the range of parameters where prices are positive. This outcome is in stark contrast with the classic result under the 'competition bottleneck' model where users on the singlehoming side benefit from intense pricing rivalry among platforms (i.e., in comparison to the benchmark with exogenous singlehoming on both sides). In contrast, platform set high membership fees for users on the multihoming side to access singlehoming members. On the opposite side, j, where there is multihoming, the incumbent's price is higher than under exogenous singlehoming within a small range of parameters, beyond which it is lower.[26] Therefore,

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[24] With respect to the entrant's price and assuming that $\overline{s_j} = \overline{s}$, $p_{-j}^{E*} > 0 \rightarrow \frac{\overline{s}}{\alpha} > 1 + \sqrt{2}$, and $2 < 1 + \sqrt{2} < 3$.

[25] See, for example, Crémer et al. (2019) at p. 6 ("In order to encourage exploration by consumers and to allow entrant platforms to attract them through the offer of targeted services, it is key to ensure that multihoming [is] possible and dominant platforms do not impede it. There are many ways to restrict multihoming or make it less attractive – once again, case by case analysis is primordial. However, we believe that any measure by which a dominant firm restricts multihoming should be suspect and such firm should bear the burden of providing a solid efficiency defence.")

[26] Assuming that $\overline{s_j} = \overline{s}$ the inequality $\frac{2\overline{s_j}}{3} - \alpha - \frac{2\alpha}{3}\left[1 + \frac{\overline{s_j}\alpha}{(\overline{s_j s_{-j}} - \alpha^2)}\right] > 0$ is determined by the following cubic equation: $2x^3 - 5x^3 - 4x + 5 = 0$, where $\overline{s} = x\alpha$. The roots of this equation are ~ -1.146, ~0.753 and ~2.9. Given the condition for the positivity of the entrant equilibrium price on side $-j$ determined above, $\frac{\overline{s}}{\alpha} > 1 + 1\sqrt{2}$, the relevant root is the third one. The cubic equation

for high levels of switching costs, the observation that prices on the side with multihoming are lower than under singlehoming is also in stark contrast with the outcome under the 'competition bottleneck' model, where multihoming users (i.e., typically sellers on a marketplace platform) face monopolistic charges to gain access to singlehoming users on the opposite side (i.e., typically buyers).

Under the same condition, $\overline{s_j} > \alpha$, the entrant's market share on side j is smaller than on side – j, which may be surprising given that the entrant doesn't charge for membership on the former side. As the incumbent maintains full coverage on side j, the entrant is forced to waive its membership fee on the same side in order to boost its ability to set a positive fee on the opposite side $-j$.

When both regimes are viable from the entrant's perspective, it is interesting to compare profits for both platforms in order to explore the incentives faced by the incumbent firm in selecting which configuration to pursue. The profits of the two platforms are as follows:

$$\pi^{I*} = \frac{2\overline{s_j s_{-j}} - \overline{s_j}\alpha - 2\alpha^2}{3\overline{s_j}} + \left[\frac{2\alpha\left(\overline{s_j s_{-j}} + \overline{s_j}\alpha - \alpha^2\right)}{3\left(\overline{s_j s_{-j}} - \alpha^2\right)}\right]^2 \quad (23a)$$

$$\pi^{E*} = \frac{\left[\alpha + 2\overline{s_j}\alpha - \overline{s_j s_{-j}}\right]^2}{9\overline{s_j}\left(\overline{s_j s_{-j}} - \alpha^2\right)} \quad (23b)$$

First, the incumbent's profit is higher when full coverage is pursued on the side where switching costs are higher, and the entrant's profit is also higher as a result. Therefore, (endogenous) singlehoming takes place on the opposite side with lower switching costs. Second, as the incumbent has the discretion to choose whether to pursue (endogenous) multihoming (i.e., on side j), or to accommodate (endogenous) singlehoming (i.e., on both sides), it is important to assess its incentives, as well as the implications for the entrant. The comparisons between the two equilibrium profit solutions for the two platforms (i.e., under Eqs. 9(a,b) and 23(a,b)) cannot be solved analytically. Therefore, below we can show graphically when the profits under the multihoming configuration are higher than under singlehoming for the two platforms for rising levels of $\frac{\overline{s}}{\alpha}$, under the simplifying assumption that $\overline{s_j} = \overline{s}$.

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is level positive for value above ~2.9, meaning that for $\sim 2.4 < \frac{\overline{s}}{\alpha} < \sim 2.9$ p_j^{I*} under endogenous multihoming is higher than under exogenous singlehoming, and lower for $\frac{\overline{s}}{\alpha} > \sim 2.9$.

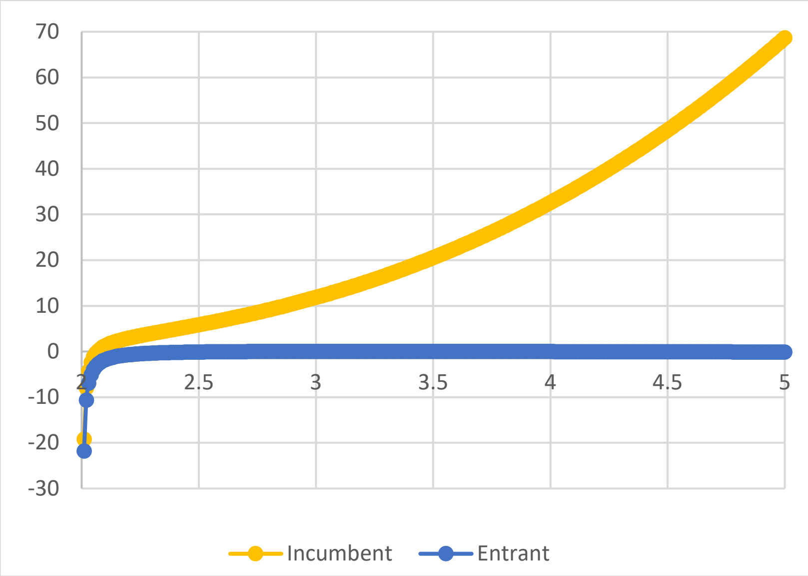

Figure 1: difference between equilibrium profits under multihoming and singlehoming for the incumbent and entrant platforms based on the level of $\frac{\bar{s}}{\alpha}$

The incumbent profit under multihoming is always higher, but for comparatively very small levels of switching costs, where, in any case, entry under either regime is not viable. However, the entrant is indifferent between the two regimes. From a policy perspective, these findings suggest that the incumbent platform should not resist multihoming, even if it is the result of regulatory intervention aimed at lowering switching costs. In addition, the indifference from the perspective of the entrant implies that the incumbent lacks the anticompetitive motive to opt for either regime in order to foreclose its rival.

As a corollary, agents tends to be, in aggregate, worse-off under multihoming (i.e., in light of the higher revenue from membership fees extracted by the incumbent platform), the more so the higher is the level in switching costs. From a distributional perspective, this should be particularly the case for agents on the side with the comparatively lower switching costs, where there is (endogenous) singlehoming, as prices are normally higher than under the configuration with (exogenous) singlehoming on both sides. This result is in stark contrast to the outcome under exogenous singlehoming, where prices are higher on the side with comparatively higher switching costs. These results suggest that regulatory intervention aimed at facilitating multihoming by lowering switching costs on one side might backfire as those targeted users could end up facing higher prices (i.e., than under exogenous singlehoming) if their side becomes the one with comparatively lower levels of switching costs thus where there is (endogenous) singlehoming.

In contrast to the previous configuration, we do not proceed to develop the model under asymmetric cross-group network benefit parameters as the solutions are too complex and thus hard to interpret.

3. Conclusions

The incumbency advantage of dominant platform is, arguably, the most prominent competition issue in the area of competition policy. A new platform trying to enter a market dominated by an incumbent platform may in fact fail to overcome the competitive disadvantage due to the combined impact of network effects and switching costs. This is particularly so where there is a lack of product differentiation and when demand is largely saturated, that is, as in mature markets for essential services and products.

Hence, the imposition of data portability in order to facilitate switching is advocated as a general template for regulatory intervention to address the dominance of digital platforms run by the likes of Amazon, Facebook and Google (e.g., Furman et al., 2019; Crémer et al., 2019; and Scott Morton et al., 2019). This paper introduced a novel attempt to model the incumbency advantage among two-sided platforms with heterogeneous switching costs on both sides of the platforms, and thus to analyse the impact of regulatory intervention aimed at making it easier for the platform users to switch to a different platform.

We model both exogenous singlehoming and endogenous multihoming on both sides. In both regimes, the presence of heterogeneous multihoming is a mixed-blessing for the entrant platform. On the one hand, it allows the incumbent to hold on to a larger market share on each side and also charge higher prices, so that profits are also materially higher. On the other hand, the case for entry depends on the range of heterogeneous switching costs. In particular, this preponderance of this demand-side friction over the intensity of cross-group network benefits is a requirement to avert tipping equilibria whereby the incumbency advantage would be further strengthened by the presence of favourable beliefs regarding the expected network size. In this respect, we find that the regime under endogenous multihoming is more accommodative towards entry, as implied by the respective conditions underpinning the concavity of the profit functions. However, the conditions for the entrant to be able to set positive prices (i.e., rather than subsidise its membership in order to secure a positive market share) is more challenging, that is, requiring even larger ranges of preference heterogeneity due to demand-side frictions. As before, we find that the endogenous multihoming regime is more favourable to the entrant than under exogenous singlehoming. In this respect, the incumbent's incentives are aligned, as its profit is higher under the former regime, whereas the entrant is substantially indifferent. Our multihoming equilibrium configuration is reminiscent, to some extent, of the classic 'competition bottleneck' model, in that multihoming takes place only on one side. However, our results differ in several respects. First, multihoming is only partial and, not surprisingly, concentrated in the segment where switching costs are lower. More surprisingly, we find that this is the less-elastic side (i.e., switching costs are comparatively higher), whereas in the 'competition bottleneck' model universal multihoming is imposed on the side where agents face no demand-side frictions. In addition, not only in the opposite (more elastic) side is there endogenous singlehoming, but, also in contrast with the competition bottleneck model, prices are higher than under exogenous singlehoming.

Our results have strong policy implications. Intervention aimed at lowering switching costs might unintendedly make entry more difficult as the incumbent's strategic stance becomes less accommodative. Perhaps counterintuitively, this suggests that this type of intervention should take place only after the entrant has managed to gain a foothold in the market, so that, once switching costs have been reduced below the threshold where tipping tendencies resume, the entrant platform is less likely to be disadvantaged by unfavourable beliefs. Our results also entail that evidence that the incumbent is unwilling to accommodate multihoming would be concerning from a competition policy point of view. First, refusing to accommodate multihoming entails a profit sacrifice, especially when switching costs are high. In addition, combined to the observation that the conditions underpinning the feasibility (i.e., positive market shares) and viability (i.e., positive fee revenue) of entry are worse under (exogenous) singlehoming, it could be argued that the incumbent's strategy is anticompetitive. This finding raises a conundrum from a regulatory perspective, given that the imposition of data portability is typically motivated by the desire to facilitate multihoming and reduce switching costs, thus giving rise to contrasting effects with respect to prospects for sustainable entry.

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