Are Preset Defaults Harmful?

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Abstract

In the search engine industry, there is intense scrutiny - and criticism, investigations, lawsuits and adverse judgments - of the practice of "preset defaults" wherein operators like Apple control entry points (such as iPhones; or Google with Chrome browser) and steer users' choice of search engine towards the designated default product. With a theoretical model which captures the essence of preset defaults, we produce several insights regarding the regulation of digital markets. While preset defaults are alleged to create and perpetuate dominance, we find that their economic implications are quite nuanced. First, preset defaults have two differently-acting mechanisms that tilt consumer adoption towards the designated firm: i) the inconvenience cost of switching out from the default acts in favor of the designated firm and against the rival, but ii) their influence on "sheep" users who blindly adopt the designated default can elicit less competitive behavior by *both* firms. Second, preset defaults are more harmful for products with weak or no network effects than for digital products with strong network effects: the direction of outcomes depends significantly on the magnitude of the product's network effects. Third, short term effects (monetization level or extent of advertising) are more negative than long-term effects (impact of defaults on innovation and quality). Preset defaults do increase market strength of the default firm and make it more difficult for the rivals to compete, however abolishing them or weakening their power may ultimately not benefit consumers, especially when the default firm indeed offers the better product. For products with strong network effects, preset default can increase consumer surplus: the default arrangement's positive impact on the designated firm's market share (and increased confidence that the market will tip in its favor) incentivizes the firm to innovate more, knowing that its investments are more likely to pay off. Our results also shed insights on many other applications where preset defaults are common, including PDF reader, web browser, and the next battlegrounds for computing: large language models (LLMs) and chatbots.

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1 Introduction

The strategic use of preset defaults has emerged as a pivotal economic lever in many domains in which an intermediary operator of a host platform (such as Apple's Safari browser or Apple's iPhone) is a launchpad for a value-added software service (such as a search engine). For instance, Google is set as the default search engine on almost all mobile devices and mobile web browsers in the UK and Australia, according to the UK's Competition and Markets Authority (2020) and the Australian Competition & Consumer Commission (2024). A preset default allows the operator to steer users to one of the competing value-added products on that platform. It acquires this power because many users do not switch their default setting (Kesan and Shah, 2006; Decarolis et al., 2023), for instance due to a status quo bias (Jachimowicz et al., 2019; Samuelson and Zeckhauser, 1988). This practice has attracted regulatory attention, including the now-famous case of *United States v. Google*.[1] The concern, allegation, and indeed current judgment[2] is that a service (search engine) that gains an early lead then secures a default position through agreements or financial incentives, thereby perpetuating its dominance and sidelining innovative or superior competitors, and hurting consumers due to lower competition and innovation (Bet et al., 2022). This paper offers a rigorous analysis of the economic consequences of default settings, by developing a game-theoretic model to unpack how the power of default impacts competition and innovation for digital services that are characterized by network effects, our prime and lead example being search engines.

The initial use of defaults often appears innocuous, providing a distribution channel for the product, while streamlining user experience and choice. However, the power of a preset default to guarantee a steady inflow of users and learning data and revenue to the chosen service carries strategic importance both in early stages of technology competition (e.g., a smartphone's default setting for a chatbot, personal assistant, or other artificial intelligence tool) and over a longer term as the market matures (as has been the case for search engines). A September 2024 report from the Australian Competition & Consumer Commission (2024)

[1] United States v. Google LLC, No. 1:20-cv-03010 (D.D.C.).

[2] The US Google Search Case Is Really About Monopolizing the Future. https://www.promarket.org/2024/08/20/the-us-google-search-case-is-really-about-monopolizing-the-future

notes that Google (with 94% of the search engine market share in Australia) remains the default search engine across most browsers due to its commercial pre-installation and default arrangements with third parties, as well as its ownership of the Chrome browser. Indeed, Google pays Apple tens of billions of dollars annually to maintain its status as the default search engine on Apple devices (Nylen, 2023). The effect is amplified when a product's utility is enhanced by (data-driven) network effects (Gregory et al., 2021; Krämer and Schnurr, 2022; Decarolis et al., 2023). Network effects require users to coordinate because they enjoy higher utility when using the same provider. As more users engage with one search engine, it gathers more click and query data, which helps to refine its algorithms, which improves utility of all of its users (Argenton and Prüfer, 2012; Schaefer and Sapi, 2023; Klein et al., 2023). This improvement attracts more users, thereby generating additional data, and perpetuating the cycle. If such network effects are strong, they can also become dominant in users' adoption decisions, overriding idiosyncratic preferences they may have for other providers. Preset defaults give the designated firm a guaranteed user network size, especially when the default exerts a more powerful force on consumers' choice. Conversely, this means the absence of such guaranteed network effects can significantly hinder the ability of rivals to challenge the designated firm in markets with strong network effects (Zhu and Iansiti, 2012).

We show that the impact of preset default, often portrayed as unequivocally detrimental to competition and innovation in digital markets, is more nuanced. We consider three measures of impact: monetization by the search engine (i.e., how product value is split between firm and user), innovation (how much product value is created), and consumer surplus, which combines the two measures. Monetization levels can be viewed as a short-term impact, while innovation captures impact in the longer term. We also examine how the impact of preset defaults depends on the strength of data-driven network effects (Krämer and Schnurr, 2022; Parker et al., 2021; European Commission, 2020; Cennamo and Sokol, 2021) vs. horizontal preferences of users that are independent of a network effect. We find that the short- and long-term impacts of default settings and the strategic interplay between firms differ significantly in case data-driven network effects are strong relative to horizontal preferences vs. when network effects are weak.

Crucially, our analysis suggests that the economic impact on consumers is more harmful for traditional goods with no or weak network effects than for products with strong network effects (and, for which, preset defaults may even lead to higher consumer surplus).

The practice of preset defaults draws more attention when a single operator influences the product choice of a large fraction of users (e.g., Apple influences users of iOS devices and Mac computers; similarly, Google affects users of Android devices and Chrome browsers, which serve as entry points for choice of search engine), and when the operator also owns one of the competing products (e.g., again, Google with search). In our model, the power of the default effect—i.e., the degree to which it shapes adoption decisions—is further represented by two key parameters. First, the population share $s \in [0, 1)$ of *passive users* who, like *sheep*, simply and blindly stick with the default choice. This may occur, for example, because they are unaware of alternatives, not tech-savvy enough to evaluate and choose, or locked into a particular product ecosystem. For search engines, s is affected by market shares of Android and Chrome browsers, combined with tech-savviness, age, and other factors that influence attitude towards choice. The remaining *active users*, like *eagles*, will scan, analyze, and make an active decision which search engine to patronize. Second, even for active users, the platform can make it more difficult to change the default, for example, by hiding the relevant settings to switch the default deep in the settings or introducing warning messages when a user intends to switch. We model this friction in changing the default as an *inconvenience cost* c.

Among the two elements that make preset defaults powerful, one (inconvenience cost c) has an unambiguous effect of favoring the designated firm (gives it greater monetization power and encourages greater investment in quality) and handicapping the rival. For the second element (s, share of sheep users), the model illuminates novel effects. First, when network effects are strong enough to cause the market to tip towards either firm, a preset default increases the designated firm's confidence in successfully recouping innovation costs that improve user utility (i.e., quality and, in inverse, level of monetization), thereby eliciting greater investment. Second, when horizontal preferences are crucial in adoption decisions (i.e., network effects are not too strong), a preset default can alleviate competitive pressure on the designated firm and cause lower quality in the long run (when the rival firm is relatively weak to begin with). The effects on the rival firm are opposite to that on the designated firm.

Overall, we establish that the effect of defaults on consumer surplus are nuanced and need careful, rigorous, analysis by scholars and to inform policymakers. Preset defaults do favor the designated firm (and handicap the rival) by increasing its power to monetize; even this finding has nuances because they can lead even the rival to monetize more, for products with weak network effects. The longer-term impact on incentives to innovate is more dependent on strength of network effects. In case of strong network effects, defaults help to reduce inherent demand uncertainty and can raise innovation levels so that consumers are overall better off–despite the fact that the default firm raises its monetization level. This only occurs if the power of the default is sufficiently strong *and* if the rival firm does not have a much better innate capability to generate network effects (e.g., a much better algorithm). Otherwise, we find that default settings lower consumer surplus.

Contribution to Literature and Practice: Our model relates to and complements recent theoretical models that explore the effects of defaults in digital markets. Chen and Schwartz (2023) introduce a model where two firms, offering competing products of different inherent qualities, participate in a bidding process with a third party responsible for assigning the default position. In contrast, our model assumes that the default position is already established, shifting our focus to analyzing the implications of this setting. Hovenkamp (2023) examines the effects of defaults on competition among search engines, which are modeled with horizontal differentiation and limited network effects, similar to our case of weak network effects. Our findings concur with some conclusions of these models, particularly the way defaults can reduce competition among search engines and increase the nuisance from monetization activities. Our primary contributions are centered on considering also strong network effects and the innovation incentives under the influence of defaults, which is one of the pivotal concerns for policymakers.

Beyond the formal theoretical literature, our study contributes to the ongoing policy discussion on the impacts of default settings on competition and innovation in digital markets

(Krämer and Schnurr, 2022; Heidhues et al., 2023). Antitrust concerns about defaults or pre-installed digital products were initially analyzed through the economic theory of tying and foreclosure, as these products (e.g., a web browser and an operating system) were typically offered by the same firm (Gilbert and Katz, 2001; Whinston, 2001).[3] More recently this has been complemented by insights from behavioral economics (Stucke, 2012; Van den Bergh, 2013; Vasquez Duque, 2023b). Recent empirical literature also sheds some light on the default effect in digital markets, based on data from regulatory changes. Decarolis et al. (2023) demonstrate that regulatory interventions limiting the default search engine settings on Android devices reduce Google's market share, underscoring the substantial impact of default positions. However, Vasquez Duque (2023a) finds that a similar intervention against Microsoft's default web browser yields only limited effects.

2 The Model

We model a market in which users choose between two competing providers (1 and 2) of a vital product (e.g., search engine). A focal *operator* such as an operating system provider influences users' adoption decisions, and designates one of these providers as a preset default. We label a product as A if it is the default, and B otherwise. The two providers each have two strategic levers that affect market share and profits, namely quality level (which requires investment) and economic tax (e.g., price or amount of data or advertising). Each product affects user utility via quality, tax, and network benefits. The two products are symmetric in many respects, including in the distribution of individual preferences that users have for one or the other. Any distinction or asymmetry between them is captured via the parameters β_i, which represent their baseline utility (separate from network effects) or even the network benefit from an initial user base resulting from previous-period adoptions by users who are not presently choosing a search engine. We assume without loss of generality that $\beta_1 \geq \beta_2$, i.e., product 1 is superior. Thus, in terms of the preset default, there are 3 scenarios depicted

[3]This is exemplified by Microsoft facing antitrust lawsuits for pre-installing its own applications into the Windows operating system. See *United States v. Microsoft* (253 F.3d 34 (D.C. Cir. 2001)) in the US and Case T-201/04 *Microsoft v. Commission* [2007] in the EU.

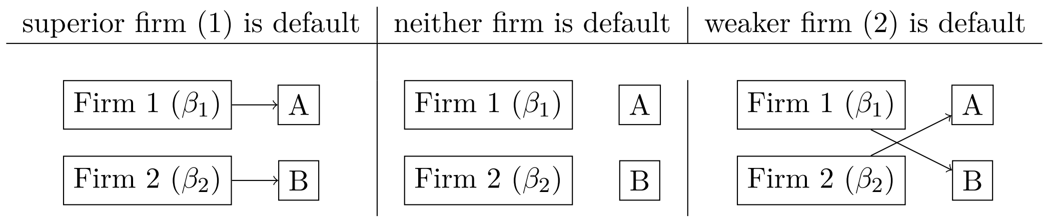


Figure 1: Scenarios for awarding preset default

in Fig. 1.

2.1 Modeling and Analysis Framework: Sheep and Eagles

Let v_i represent the search engines chosen innovation levels, p_i the tax that they impose on users, and α the intensity of network effects. The tax might be a monetary price or an alternative mechanism such as advertising monetization; for clarity in exposition we just refer to it as *monetization level*. Improving product quality involves an innovation cost, convex on the quality achieved; we adopt $C(v) = {}^{v^2}\!/2$. Potential users of the search engines arrive from two different sources, as indicated in Fig. 2. First, a fraction λ of users depends on a focal operator, such as an operating system provider. This segment splits further into two, a "sheep" group (fraction s) who passively accept the default setting (e.g., because they are not aware of alternatives or are not tech-savvy enough to change the default), and "eagles" who are intentional and selective in their choice: they explore their options, weigh the pros and cons, before setting their search engine. However, these users incur an inconvenience cost c if they wish to switch the setting from the default A to B. The second segment, fraction $1{-}\lambda$ of users, have alternate entry points, and adopt a search engine purely based on tax and quality; alternately, these are users who find it painless to switch from a designated default to their preferred product. For example, Apple's designation of Google as the default search engine influences the choices of Apple users, but does not affect the choices made by users of Windows laptops. To summarize, there are overall three groups $g \in \{sheep, eagles, outside\}$ in proportions $\{\lambda s, \lambda(1{-}s), 1{-}\lambda\}$, of which the first group is made captive to search engine A.

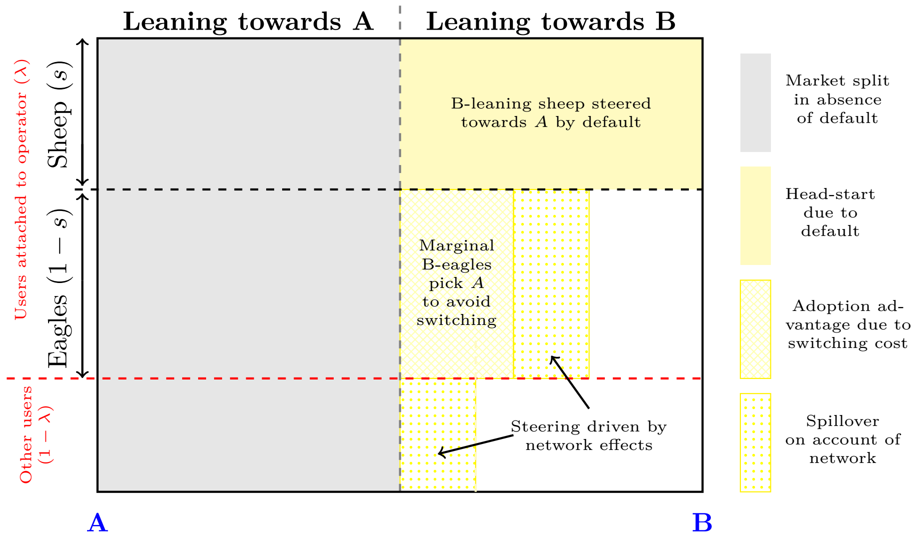


Figure 2: How preset defaults tilt consumer adoption towards A. Potential users are distributed throughout the rectangle. The y-axis partitions users who depend on the focal operator (and further whether they are sheep or eagles) from those who do not. The x-axis represents preference towards search engine A vs. B.

2.2 Overview of the Power and Consequence of Preset Defaults

First, consider consumers' search engine adoption decisions. In Fig. 2, potential users are distributed throughout the rectangle, with the y-axis partitioning users who depend on the focal operator from those who do not. The x-axis represents preference towards one or the other search engine (as in a typical Hotelling framework), with the dashed vertical line separating users who, in absence of any preset default, would prefer search engine A (to the left of the line) vs. B (right), given the levels of other parameters (such as qualities and prices and existing market shares). One consequence of preset defaults is that it confers A with three advantages in *consumer choice and adoption*. First, A gets a head-start in the race by capturing the guaranteed sheep segment. Second, the extra cost of switching away from the default even forces *some* of the B-leaning eagles to stick with A. And, third, there is a snowball effect of persuading additional B-leaning users to stay with A, because of network effects, where a search engine's user base enables it to have more data and then improve its product. All of these effects–the power of preset defaults–get stronger under higher share of sheep users

(s), when the operator controls a bigger share of the market (λ) and when the operator can impose greater cost (or effort) c on those who want to switch out of the preset default.

The second consequence of preset defaults is on the *monetization level* of the two search engines. Firm A can leverage its built-in advantage on customer adoption and market share, into higher monetization power, by showing more ads or setting a higher price. Whether and how much A leverages the advantage for market share vs. monetization depends partially on the actions of search engine B. One, B is pressured to monetize less (e.g., to show less ads) in order to win over customers, especially when network effects are strong and the search market exhibits a winner-takes-all dynamic. Second, though, if consumer preferences towards a specific search engine are high, enabling A to be quite aggressive in its monetization increase, this might allow search engine B to also increase its monetization level, as its brand loyal customers are now less likely to switch to the rival search engine.

The third consequence of preset defaults concerns the *innovation incentives* for search engine firms. Here again, countervailing forces are at play. On one hand, search engine A's advantage from being the default, which grants it guaranteed demand by sheep-like users, can lead to *complacency* in its competition with B for eagle-like users, resulting in reduced investment in search engine improvements to attract customers. On the other hand, increased user adoption and a larger customer base due to this default advantage create an incentive to innovate more because the fixed costs of innovation can now be spread across (and recouped from) a larger customer base. Specifically, when network effects create uncertainty in market outcomes, a preset default makes it more likely that the market tips in favor of the default firm, and this reduction in market uncertainty makes the firm more *driven* to invest. The overall impact on A's innovation efforts will depend on the relative strength of these opposing forces, which in turn depend on the power of the preset defaults. For search engine B, these countervailing forces also apply, but in the opposite direction; thus, when A raises its level of innovation, B tends to reduce its innovation efforts, and vice versa.

Understanding how these diverse effects combine, especially how the direct effects on adoption induce additional changes in monetization and innovation levels (and, eventually, consumers' overall welfare), requires careful analysis. Some intuition exists. For instance if A is quite weak or small initially, then it may prefer to leverage the default-advantage to grow its market share (vs. monetize more) and become a better rival to B; but if A is also inferior (with respect to users' utility) then giving A the advantage should ultimately be detrimental to users. Alternately, if A is initially strong, then the default should help it perpetuate its dominance and can hurt users via higher monetization and less pressure to innovate, even if A were the superior product. Overall, though, a thorough analysis requires a formal model, which we provide and analyze in subsequent sections. Table 1 summarizes our notation.

Search engines' decision variables	
p_i	monetization tax level of search engine i
v_i	innovation level of search engine i
Other variables	
$u_i(x)$	utility of outside user who is located at x and uses search engine i
n_i^e	number of users of search engine i
Π_i	profit of search engine i
Parameters	
λ	share of total users under the operator's control
s	share of users under the operator's control who are "sheep"
c	inconvenience cost from choosing the non-default search engine
α	strength of network effects
β_i	baseline utility for users of search engine i
t	user's disutility from horizontal preferences
m	search engines' ability to monetize their service

Table 1: Table of Notations

2.3 Consumer Choice of Search Engine

Let n_i^e be the expected total numbers of users of search engine i, which equals D_i under fulfilled expectations (see the demand parts of Eq. 2a)). As noted earlier, the sheep group of users will stick with the preset default firm A, giving us $D_{A,\text{sheep}} = \lambda s$. Remaining users make a rational decision about which platform to patronize (total mass $\lambda(1-s)+1-\lambda$). These users are in aggregate symmetric (*ceteris paribus*) with respect to their relative preference between the two search engines, and the symmetry can be captured with, say, a traditional Hotelling choice setup. The two groups differ in one respect. Whereas the $1-\lambda$ unattached users, who arrive outside of the operator, choose their best search engine, the eagles who prefer B must contend with the inconvenience cost c of switching the default. For example, the platform can deliberately introduce friction in the switching process by hiding the relevant settings to switch the default deep in the settings, or by introducing warning messages (also known as "scare screens") when a user intends to switch.

The choice of these two groups is identified by the higher of their two net utilities. Let $u_i(x)$ be the utility of a user located at x adopting search engine i, with the search engines located at the extremes of a unit Hotelling line, and t a misfit cost, linear in distance from x to the search engine's location. Some products have strong network effects, and then coordination and group utility (network benefit) is more consequential to adoption than personal preference; for other products with weaker network effects, individual preferences (captured in t) have a consequential role. Then, the consumer choice problem is summarized via the equations below:

$$u_A(x) = \beta_A + v_A + \alpha n_A^e - tx - p_A \quad \text{vs.} \quad u_B(x) = \beta_B + v_B + \alpha n_B^e - t(1-x) - p_B \tag{1a}$$

$$\text{choice}(g, x) = \begin{cases} A & \text{if } g \text{ is sheep} \\ i = \arg\max_{A,B}\{u_A(x), u_B(x) - c\} & \text{if } g \text{ is eagle} \\ i = \arg\max_{A,B}\{u_A(x), u_B(x)\} & \text{if } g \text{ is outside} \end{cases} \tag{1b}$$

Here, β_A and β_B are the baseline utility for users, v_A and v_B the respective values of a search engine's innovation efforts to users, n_A^e and n_B^e the expected total numbers of users of a given search engine, and p_A and p_B are the disutility from the monetization tax. Further, α is the strength of the network effects and t is the strength of horizontal preferences. We assume that the baseline utility from using a search engine β_A and β_B are sufficiently high such that all users prefer to use a search engine in equilibrium rather than dropping out from the market completely.

Besides dropping the sheep segment into firm A's lap, the preset default also gives it an advantage with respect to the demand levels $D_{A,\text{eagles}}$ and $D_{A,\text{outside}}$ from the eagle and unattached groups. For both subgroups, the guaranteed network effects from sheep users spurs their expectation of network effects when joining search engine A. And, for the eagles group, the default-induced inconvenience costs when switching to the rival firm make the default firm's demand less elastic (and the rival firm's demand more elastic). Thus, everything else equal, a firm's expected demand increases in one's own innovation level, $\frac{\partial D_{i,\text{eagles}}}{\partial v_i} > 0$ and $\frac{\partial D_{i,\text{outside}}}{\partial v_i} > 0$, and the rival's monetization level, $\frac{\partial D_{i,\text{eagles}}}{\partial p_{-i}} > 0$ and $\frac{\partial D_{i,\text{outside}}}{\partial p_{-i}} > 0$, but decreases in one's own monetization level, $\frac{\partial D_{i,\text{eagles}}}{\partial p_i} < 0$ and $\frac{\partial D_{i,\text{outside}}}{\partial p_i} < 0$, and the rival's innovation level, $\frac{\partial D_{i,\text{eagles}}}{\partial v_{-i}} < 0$ and $\frac{\partial D_{i,\text{outside}}}{\partial v_{-i}} < 0$. However, the presence of network effects can cause non-standard outcomes (multiple "solutions") in the solution to the choice problem (Eq. 1b). We discuss this in detail in the model analysis below.

2.4 Search Engines' Business Models and Decisions

The two search engines seek to optimize their profits,

$$\Pi_A = R_A \left(D_{A,\text{sheep}} + D_{A,\text{eagles}} + D_{A,\text{outside}} \right) - \frac{v_A^2}{2}, \tag{2a}$$

$$\Pi_B = R_B \left(D_{B,\text{eagles}} + D_{B,\text{outside}} \right) - \frac{v_B^2}{2}, \tag{2b}$$

where $R_i(D_i)$ is search engine i's revenue at total demand $D_i = \sum_g D_{i,g}$. We model the monetization activities of search engines broadly, and let $R_i(D_i) = m \; p_i \; D_i$, where p_i is the search engine's monetization level per user (a disutility to users, due to rent extraction or nuisance from advertising or data collection), and m is a scaling parameter that depends on the chosen business model and how well the search engine can monetize its service. Our modeling approach is also consistent with direct subscription-based revenue models, employed by new challenger search engines, such as Kagi.[4] In this case, p_i can be readily interpreted as the subscription price. For a subscription-based business model, where p_i is measured in monetary terms, there is a one-to-one correspondence between consumers' disutility and rent extraction, so that $m = 1$. For other business models, e.g., based on advertising or user data

[4]See https://kagi.com.

monetization, m would have to be scaled appropriately. In the limit, a search engine may not be able to monetize its service at all, and this case is also covered by our model by m approaching zero. In general, the higher m, the better is the search engines' ability to monetize its service relative to the disutility this creates for users.

The timing of the model is as follows: in stage 1, the firms simultaneously choose their innovation levels v_i; in stage 2, the firms simultaneously choose their monetization levels p_i; and in stage 3, the users decide which search engine to adopt. Thus, users can observe firms' innovation efforts v_i and the monetization levels p_i when making adoption decisions. We derive the Subgame Perfect Nash Equilibrium of this game, which also entails that users form rational expectations when choosing a search engine, and that their expectations must be fulfilled in equilibrium.

3 Analysis Framework

We begin our analysis by examining how preset defaults affect users' choice of search engine for non-sheep users, those who analyze and pick the product with the best cost-benefit ratio while also considering and making expectations about other users' choices. Given the research questions of interest and to avoid needless complexity in mathematical expressions, we frame our analysis with λ=1 (i.e., the operator exerts influence over the entire market). Intuitively, when λ is less than 1, all the consequences described below will be mitigated, and we confirm this intuition in Appendix B.

3.1 Eagles' choice of product

Consider the choice problem of eagles. By (1b) an eagle, located at x chooses search engine A if $u_A(x) \geq u_B(x) - c$, and search engine B otherwise. Substituting (1a) and rearranging yields the condition for A to be preferred by x (subject, additionally, to non-negative surplus).

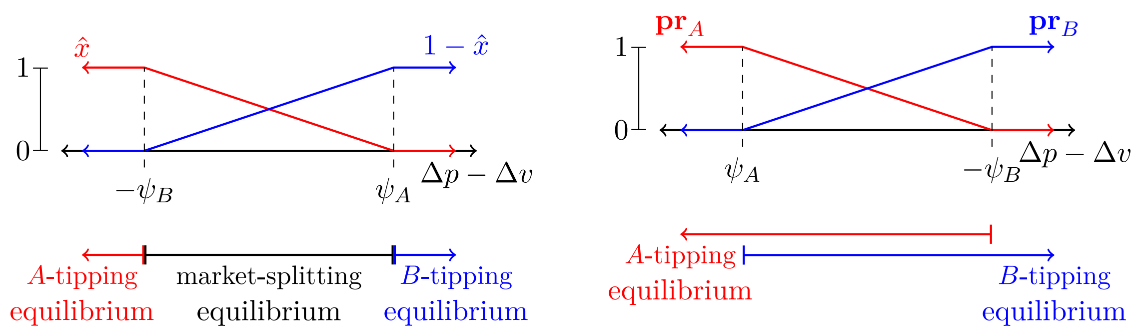
$$\underbrace{t(2x-1)}_{\substack{\text{horizontal}\\ \text{preference}}} - \underbrace{c}_{\substack{\text{cost to}\\ \text{switch default}}} - \underbrace{(\beta_A - \beta_B)}_{\substack{\text{difference in}\\ \text{baseline utilities}}} - \underbrace{\alpha(n_A^e - n_B^e)}_{\substack{\text{difference in}\\ \text{network effects}}} \leq \underbrace{(v_A - v_B)}_{\substack{\text{difference in}\\ \text{innovation}}} - \underbrace{(p_A - p_B)}_{\substack{\text{difference in}\\ \text{monetization}}}. \quad (3)$$

To the right of the inequality are differences in utility due to the search engines innovation and monetization efforts, which are determined strategically in the competitive process. To the left are 4 other forces that affect consumers' demand for a given platform: i) consumers' individual preferences (set on a horizontal line), ii) inconvenience costs of switching the search engine, and iii) the difference in base utilities (i.e., the superiority of product A over product B, and/or advantage from a larger initial user base), and iv) the difference in network effects arising from potentially asymmetric consumer adoption. We combine these forces into the firms' respective *intrinsic strength* terms, ψ_A and ψ_B, their innate potential for attracting users (role of t, c, and $\Delta\beta = \beta_A - \beta_B$, and irrespective of the competitively chosen monetization and innovation levels) pitted against the worst-case scenario of network effects favoring the rival. Note that sheep users give firm A a *guaranteed network effect* $\alpha_A s$, and 0 to firm B. The worst-case *maximal network effect* against B is that A gets all eagles (besides sheep users), and for A is that the rival captures all eagle users.

$$\begin{aligned}
\psi_A &= \underbrace{t}_{\text{inflexibility in user's preference}} + \underbrace{c}_{\text{cost to switch default}} + \underbrace{\Delta\beta}_{\text{superiority of default product}} + \underbrace{\alpha\, s}_{\text{guaranteed network effect from the sheep}} - \underbrace{\alpha\,(1-s)}_{\text{maximal network effect if all eagles join rival}} \\
\psi_B &= t - c - \Delta\beta + \alpha \cdot 0 - \alpha\,(s + (1-s))
\end{aligned} \tag{4}$$

3.2 Individual (horizontal) preferences vs. Group (network) effects

The discussion in Section 3.1 highlights that eagles' choice, given the firms' decisions p_i and v_i, crucially depends on the relative strengths of group preferences (network effects) vs. individual ones. In a typical discrete choice problem, the indifferent eagle user $\hat{x}$ is identified as $x : (u_A(x) - u_B(x)) = 0$, and the utility difference $u_A(x) - u_B(x)$ is *monotonic* in x (and decreasing when A is at 0 and B at 1), reaching 0 either at an interior $\hat{x} \in (0, 1)$, or at a boundary. This monotonic property holds when network effects are nil or weak, defined specifically as the total group-related utility (sum of the firms' network effect strengths, $2\alpha(1-s)$) being less than the sum of individual-based strengths ($2t$). This is equivalent to



(a) Weak network effects: Equilibrium demand and market shares of eagles.

(b) Strong network effects: Firms' expectations on eagles' equilibrium selections.

Figure 3: Eagle users' product adoption choice and demand equilibrium.

$(\psi_A + \psi_B) \geq 0)$, and then Eq. 1b yields $\hat{x} = D^{\text{weak}}_{A,\text{eagles}}$ (eagles' market captured by A) as

$$\hat{x}(\Delta v, \Delta p) = \begin{cases} 0 & \text{if} \quad \Delta p - \Delta v \geq \psi_A \\ \frac{\Delta v - \Delta p + \psi_A}{\psi_A + \psi_B} & \text{if} \quad -\psi_B < \Delta p - \Delta v < \psi_A \\ 1 & \text{if} \quad \Delta p - \Delta v \leq -\psi_B \end{cases} \tag{5a}$$

$$D^{\text{weak}}_{A,\text{eagles}} = (1-s)\hat{x}(\Delta v, \Delta p), \tag{5b}$$

where $\Delta p \equiv p_A - p_B$ and $\Delta v \equiv v_A - v_B$. Demand for search engine B is $D^{\text{weak}}_{B,\text{eagles}} = (1-s) - D^{\text{weak}}_{A,\text{eagles}}$. Fig. 3a depicts the choice outcomes for this case of weak network effects.

However, when network effects are strong, it is possible that for some (p_i, v_i) (and the exogenous parameter values), the utility difference is higher at both 0 and 1 than in the interior region. In other words, when network effects dominate choice, the adoption equilibrium is for all eagles to pick the same firm, A or B. Such *market tipping* is typical in digital markets, and occurs when the total group-related utility (sum of the firms' network effect strengths, $2\alpha(1-s)$) exceeds the sum of individual-based strengths ($2t$), equivalent to $(\psi_A + \psi_B) < 0)$.

With strong network effects, the value from a large network overpowers horizontal preferences, and it is advantageous for all eagle users to adopt the same search engine in a fulfilled expectations equilibrium. But, which search engine is the chosen one? Multiple possibilities arise here, and are depicted in Fig. 3b, where pr_i is the probability of eagles tipping towards firm i. First, it might be dominant for all eagles to adopt A (yielding $n^e_A = 1$), which occurs when $u_A \geq u_B$ under $n_A^e = 1$, i.e., $\Delta p - \Delta v \leq -\psi_B$. Second, and similarly, all eagles will adopt B if $u_B \geq u_A$, given the fulfilled expectations $n_A^e = s$ and $n_B^e = 1 - s$; here, all sheep user go to A while all eagles use B, which implies $\Delta p - \Delta v \geq \psi_A$. Third, though, it is possible for *both* conditions to be satisfied for certain values, specifically if (and only if) $\psi_A < \Delta p - \Delta v < -\psi_B$.[5] That is, these values of $(\Delta v, \Delta p)$ yield a *tipping equilibrium* in which all eagles can tip either to A or to B, and such that the probability placed on emergence of an i-tipping equilibrium is proportional to the relative utility that search engine i provides (if picked by eagles). In particular, expressing differences in utility through Δv and Δp, we write the probability of equilibrium with all eagles adopting A as

$$\mathbf{pr}_A(\Delta v, \Delta p) = \begin{cases} 0 & \text{if} \quad \Delta p - \Delta v \geq -\psi_B \\ \frac{\Delta v - \Delta p - \psi_B}{-(\psi_A + \psi_B)} & \text{if} \quad \psi_A < \Delta p - \Delta v < -\psi_B \\ 1 & \text{if} \quad \Delta p - \Delta v \leq \psi_A \end{cases} \tag{6}$$

with $\mathbf{pr}_B(\Delta v, \Delta p) = 1 - \mathbf{pr}_A(\Delta v, \Delta p)$.

Taken together, expected demand of search engine A from eagles under strong network effects is given by

$$D^{\text{strong}}_{A,\text{eagles}} = (1 - s)\, \mathbf{pr}_A(\Delta v, \Delta p),$$

and consequently demand for search engine B is $D^{\text{strong}}_{B,\text{eagles}} = (1 - s) - D^{\text{strong}}_{A,\text{eagles}}$. Finally, notice that both under strong and weak network effects, the demand functions show the properties assumed above.

3.3 Firms' Decisions

Search engine firms make innovation decisions in stage 1 of our game, where each firm $i = A, B$ chooses the innovation level v_i. In stage 2, search engines then make monetization

[5] Formally, if $\psi_A < \Delta p - \Delta v < -\psi_B$, there also exists an interior equilibrium in which some of the eagles choose A while other eagles choose B. In other words, while the three types of adoption equilibria happen under disjoint conditions when network effects are weak, they can all co-exist when the network effects are strong and $\psi_A < \Delta p - \Delta v < -\psi_B$. However, when network effects are strong, the market-splitting equilibrium is unstable, in the sense that if a small deviation from the equilibrium occurs, the best-response dynamics will never bring the adoption back to the equilibrium.

decisions, given their innovation levels determined in stage 1. Each firm seeks to maximize its expected profit. We solve the game with backward induction, starting with the stage-2 monetization decision and then feeding p_A^*, p_B^* back into the profit function to solve for the optimal investments in innovation. To ensure that the equilibrium exists and is stable, we assume that $|9(\psi_A + \psi_B)| > 4m(1-s)$.[6]

3.3.1 Strong Network Effects

This is the case where network effects dominate users' choice, putting aside individual preferences. When multiple equilibria are possible, we adopt the principle that firms' actions are guided by expectations on which equilibrium emerges. These expectations are based on the resulting utility that customers enjoy when eagles pick A vs. pick B: higher the utility that search engine i provides (if picked by eagles), the higher is the probability placed on emergence of that equilibrium. With Eq. 6, the interpretation is that firms expect an equilibrium outcome with certainty when parameter conditions imply the equilibrium to be unique (i.e., $\Delta p - \Delta v < \psi_A$ or $> -\psi_B$). And, when multiple competing equilibria are feasible, each firm can improve its chances of capturing all the eagle users by improving its quality or reducing its monetization tax.

For sharper illumination of the findings, we consider an extreme case where individual preferences become inconsequential, i.e., $t = 0$, and users make affiliated choices regarding which search engine to adopt. With the likelihood of a tipping outcome (with all eagles choosing the same firm), the expected profits of the two firms are

$$\Pi_A(v_A, v_B; p_A, p_B) = m\, p_A \left[s + (1-s)\mathbf{pr}_A(\Delta v, \Delta p)\right] - \frac{v_A^2}{2} \tag{7a}$$

$$\Pi_B(v_A, v_B; p_A, p_B) = m\, p_B \left[(1-s)(1 - \mathbf{pr}_A(\Delta v, \Delta p))\right] - \frac{v_B^2}{2}. \tag{7b}$$

An equilibrium requires that the stage 1 monetization levels satisfy $(\Delta p - \Delta v) - c \in [\alpha(2s-1), \alpha]$.

[6] The sufficient condition for a Nash equilibrium in the innovation stage to be locally asymptotically stable (see Fudenberg and Tirole, 1991, p. 24) is

$$\frac{\partial^2 \pi_A}{\partial v_A^2} \cdot \frac{\partial^2 \pi_B}{\partial v_B^2} > \frac{\partial^2 \pi_A}{\partial v_A \partial v_B} \cdot \frac{\partial^2 \pi_B}{\partial v_A \partial v_B}.$$

For price levels outside this range, the firm could increase its monetization level without reducing consumer adoption, i.e., without lowering $\mathbf{pr}_i$. Therefore, in equilibrium it must be that the monetization levels are interior and can be characterized by the first-order conditions. The equilibrium innovation and monetization levels are summarized below.

Lemma 1 (Monetization and Innovation Levels under Strong Network Effects)**.** *Given the innovation levels v_A and v_B, the equilibrium monetization and innovation levels are*

$$p_A^*(\Delta v) = \frac{1}{3}\left[3\alpha + 2\alpha s + c + \Delta\beta + \Delta v\right] \tag{8a}$$

$$p_B^*(\Delta v) = \frac{1}{3}\left[3\alpha - 2\alpha s - c - \Delta\beta - \Delta v\right]. \tag{8b}$$

The equilibrium innovation levels are

$$v_A^* = \frac{m}{3}\left[\frac{3(3\alpha + 2\alpha s + c + \Delta\beta) - 2m}{9\alpha - 2m}\right] \tag{9a}$$

$$v_B^* = \frac{m}{3}\left[\frac{3(3\alpha - 2\alpha s - c - \Delta\beta) - 2m}{9\alpha - 2m}\right]. \tag{9b}$$

3.3.2 Weak Network Effects

With market splitting under weak network effects, firms seek to maximize expected profits given by the expressions

$$\Pi_A(v_A, v_B; p_A, p_B) = m\, p_A\left[s + (1-s)\hat{x}(\Delta v, \Delta p)\right] \tag{10a}$$

$$\Pi_B(v_A, v_B; p_A, p_B) = m\, p_B\left[(1-s)(1 - \hat{x}(\Delta v, \Delta p))\right]. \tag{10b}$$

Lemma 2 (Monetization and Innovation Levels under Weak Network Effects)**.** *In a market-splitting equilibrium, the innovation levels v_A and v_B, and the two firms' equilibrium monetization levels are*[7]

$$p_A^*(\Delta v) = \frac{1}{3}\left[\left(\frac{3+s}{1-s}\right)t - 3\alpha + c + \Delta\beta + \Delta v\right] \tag{11a}$$

$$p_B^*(\Delta v) = \frac{1}{3}\left[\left(\frac{3-s}{1-s}\right)t - 3\alpha - c - \Delta\beta - \Delta v\right]. \tag{11b}$$

[7] For the equilibrium to be market-splitting, it must be that $\hat{x}(\Delta v^*, \Delta p^*(\Delta v^*)) \in (0, 1)$. In addition, firm A must also have no incentive to completely neglect the eagle segment of the demand.

The equilibrium innovation levels are

$$v_A^* = \frac{m(1-s)}{3}\left[\frac{3\left(\left(\frac{3+s}{1-s}\right)t - 3\alpha + c + \Delta\beta\right) - 2m}{9[t-(1-s)\alpha] - 2m(1-s)}\right] \tag{12a}$$

$$v_B^* = \frac{m(1-s)}{3}\left[\frac{3\left(\left(\frac{3-s}{1-s}\right)t - 3\alpha - c - \Delta\beta\right) - 2m}{9[t-(1-s)\alpha] - 2m(1-s)}\right]. \tag{12b}$$

4 Results and Intuitions

The model expresses the equilibrium strategic choices in terms of whether the products occupy the default position or not (i.e., in terms of A and B). Thus, the scenario where the superior firm is preset as default is $A = 1, B = 2$, the scenario where the weaker firm is default is $A = 2, B = 1$, and the scenario where neither firm occupies the default is represented by $A = 1, B = 2$, but with $s = 0, c = 0$.[8]

4.1 Monetization and innovation strategy

Lemma 1 immediately gives rise to the intuition, formalized below, that being assigned the preset default increases a firm's power in setting monetization level, while the rival firm has to compete more fiercely by lowering its monetization levels. However, the latter effect is nuanced, and the two mechanisms that make preset defaults powerful act in different ways.

Corollary 1 (Lemma 1, impact on monetization)**.** *Given the firms' innovation levels, a preset default enables the designated firm to have a higher monetization level, and the effect is amplified under higher c (inconvenience cost c of switching the default) and higher s (share of sheep users). The rival firm's monetization level is reduced when network effects are strong (relative to individual preferences), but can be higher when network effects are weak (i.e., individual preferences are decisive and s is high).*

Corollary 1 illuminates the divergent roles of the two aspects that make preset defaults powerful. The cost of switching c has a predictable effect: it favors the designated firm A and, conversely, acts against its rival B. However, the share of sheep users s can cause both firms to raise their monetization levels (which harms consumers) when network effects are weak and

[8]In case of no default, the labels A and B as identifiers for the designated and non-designated firm, respectively, become meaningless, and thus we might as well have set $A = 2$ and $B = 1$.

individual preferences have a significant impact on consumer utility. The contrasting impact of s for weak vs. strong network effects occurs because both firms' optimal monetization strategy is determined by a trade-off between two countervailing forces, which is influenced by the strength of the network effects. On one hand, the firms' monetization levels are strategic complements, meaning that as one firm raises its monetization level, the best response of the other firm is also to raise its monetization level. By this force, since the default allows the designated firm to increases its monetization level, so does the non-default firm. The second force relates to network effects, which guarantee more users to one firm and cause the second firm to fight harder for users (i.e., monetize less). When network effects are strong, it exerts a big effect on the choice of eagles, hence this second force dominates and the significantly disadvantaged non-default firm must reduce its monetization level. When network effects are quite weak, this force fades and the rival can increase its monetization in line with the complements aspect of monetization levels.

These impacts of the default on monetization levels (while holding innovation levels constant) can be interpreted as the short-term effect of defaults. But how do preset defaults shape innovation and investments by the firms in the longer term? Intuitively, and given the firms' economic considerations and competition, there are 3 forces that impinge on how preset defaults affect firms' investments in innovation: i) *Expected Scale Effect*: upfront fixed costs of innovation are more palatable to a firm if it can recoup those costs with a large (expected) market, thus a preset default favors A and handicaps B, ii) *Monetization Effect*: for A, higher innovation investments, which increase demand, become more lucrative under high per-user margins, and the rival can either grab more market share (reduce its monetization) or follow with higher monetization (see Corollary 1),[9] and iii) *Complacency Effect*: the captive sheep users under preset default give A less reason to compete for eagles, and thereby makes it easier for B to attract eagles through innovation (although there are overall fewer of them that can be won over). This reduces innovation incentives for A, but can increase innovation incentives for B. As we explain next, these effects play out differently under strong and weak network

[9] Mathematically, this means that $\frac{\partial D_A}{\partial v_A}\frac{\partial p_A}{\partial s} > 0$ and $\frac{\partial D_A}{\partial v_A}\frac{\partial p_A}{\partial c} > 0$.

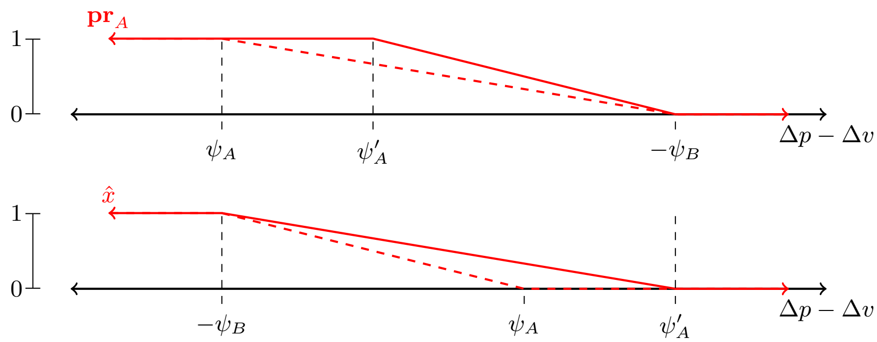


Figure 4: An increase in the sheep-like users s increases A's market strength from ψ_A to ψ'_A, but does not change B's market strength ψ_B. *Top:* Under strong network effects ($\psi_A < -\psi_B$), an increase in s makes the A-tipping equilibrium more likely, ceteris paribus. The dashed line represents $\mathbf{pr}_A$, the expectation that the A-tipping equilibrium is chosen for a given pair $(\Delta v, \Delta p)$, before the increase in s, and the solid line the corresponding expectation after the increase in s. *Bottom:* Under weak network effects ($\psi_A > -\psi_B$) an increase in s shifts the indifferent consumer towards B, which means that more users choose A, ceteris paribus. The dashed line represents $\hat{x}$, the location of the user indifferent between choosing A (located at 0) and B (located at 1) before the increase in s, and the solid line the corresponding expectation after the increase in s (which increases A's market strength from ψ_A to ψ'_A).

effects, and for the default and non-default firm, and lead to our key result below.

Proposition 1. *The impact of preset defaults on firms' innovation levels varies by strength of network effects. (i) Under strong network effects, they lead to higher innovation by the designated firm A and lower by the rival B, and these effects are amplified by the share of sheep users s and inconvenience cost c. But, (ii) when network effects are weak and the non-default firm is relatively weak ($\psi_B < {}^2\!/\!_9\, m$), preset defaults can cause lower innovation by A (and, conversely, higher by B).*

Proposition 1 highlights that the innovation consequences of preset defaults vary by the nature of the product in terms of network effects. For many digital goods with strong network effects, preset default can actually cause the designated firm A to innovate more. This is because market outcomes are inherently uncertain in such markets given the likelihoods of market tipping towards either firm. The preset default not only guarantees A the sheep users, but also amplifies eagle users' tilt towards A caused by the switching cost, thereby making it more likely that all eagles will coordinate on choosing A rather than B. Hence, the *expected scale* effect dominates the other two effects when network effects are strong by reducing the risk it perceives in an innovation investment. This is exemplified by the top panel in Figure

4. As s increases, it becomes more likely that an A-tipping equilibrium is unique, while the region for competing equilibria shrinks, improving A's confidence in winning over eagles (if $\psi_A < \Delta p - \Delta v < -\psi_B$). Moreover, a marginal increase in innovation by A (increasing Δv) now induces a stronger change in the eagles' expected adoption of the A-tipping equilibrium (i.e., the slope of $\mathbf{pr}_A(\Delta v, \Delta p)$ increases).[10] Consequently, under strong network effects, eagles become more responsive to A's innovation, as the default draws in more sheep-like users. Under weak network effects, however, the risk reduction effect is weak and eagles become less responsive to A's innovation (the slope of $\hat{x}$ decreases for higher s, in the bottom panel of Figure 4),[11] discouraging innovation by A.

Incremental innovation by designated firm (A) under preset defaults relative to no defaults (under strong network effects)

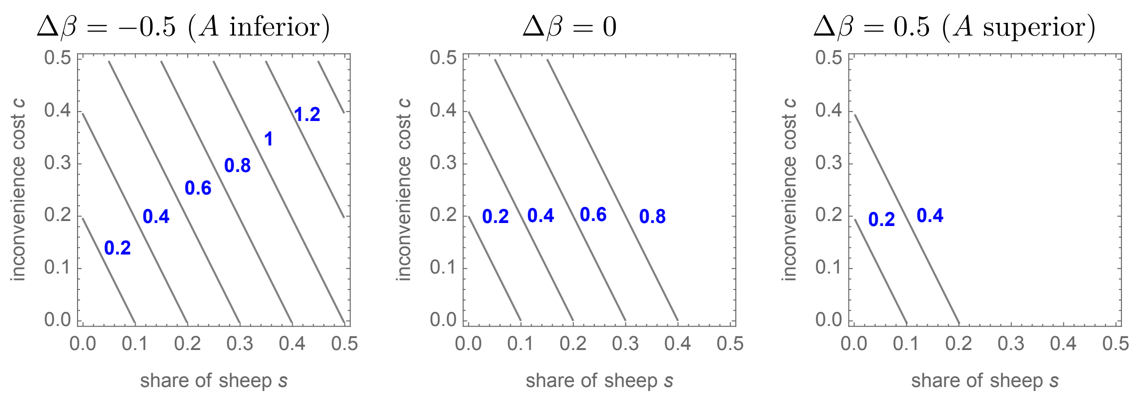


Figure 5: How preset defaults impact *innovation levels* of the designated firm under *strong network effects* and different values of the designated firm's product superiority $\Delta\beta$. All points on a contour represent the same level of increment in innovation relative to the no-default case (blue is positive increment, red is negative). Incremental innovation by the rival firm has the same magnitude, but opposite sign. The other parameters are $\alpha = 1$ and $m = 3$.

Proposition 1 also highlights the divergent role of the two forces that lend power to preset defaults, captured by s and c. While the impact of sheep users on innovation levels can flip based on strength of network effects (above), how the inconvenience cost of switching c affects the direction of innovation incentives does not. Although c has a similar effect as s in shifting the eagles' demand in favor of the default firm, it does not (like s) affect the eagles'

[10] Mathematically, this means that $\frac{\partial^2 \mathbf{pr}_A(\Delta v, \Delta p)}{\partial v_A \partial s} > 0$.

[11] Mathematically, this means that $\frac{\partial^2 \hat{x}(\Delta v, \Delta p)}{\partial v_A \partial s} < 0$.

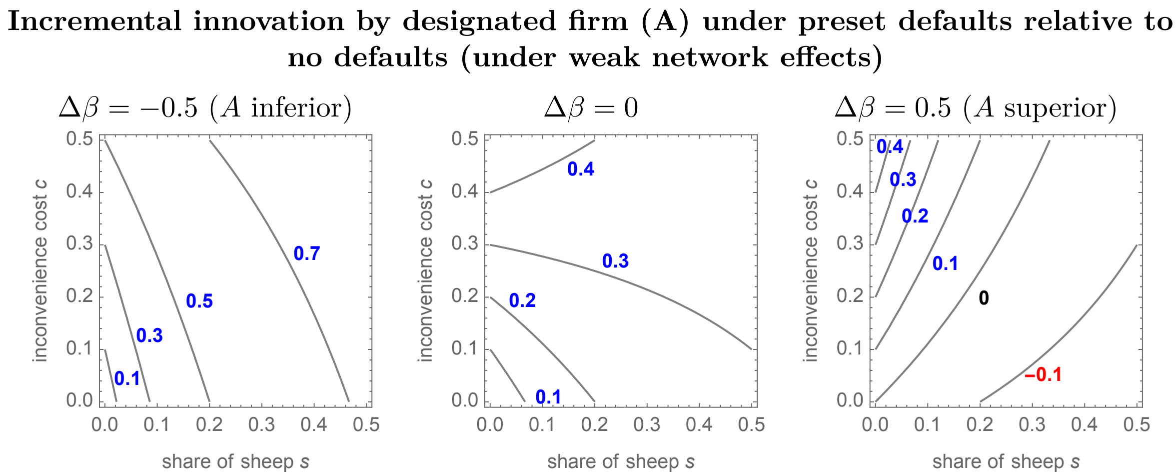


Figure 6: How preset defaults impact *innovation levels* of the designated firm under *weak network effects* and different values of the designated firm's product superiority $\Delta\beta$. All points on a contour represent the same level of increment in innovation relative to the no-default case (blue is positive increment, red is negative). Incremental innovation by the rival firm has the same magnitude, but opposite sign. The other parameters are $\alpha = 1$, $t = 2$, and $m = 3$.

responsiveness to innovation *per se*. To see this, note that a change in c would merely shift the boundaries ψ_A and $-\psi_B$ in Figure 4 symmetrically, and would therefore not change the slope of $\mathbf{pr}_A$ or $\hat{x}$, respectively–unlike a change in s, for which the change in slope is highlighted in Figure 4. A change in the inconvenience costs does therefore not have a qualitatively different effect under strong vs. weak network effects.

However, there is also an aspect to firm A's complacency in fighting for eagles, which works in opposite directions for the default and the non-default firm. A's complacency is especially pronounced when network effects are weak and firm B has low market strength ψ_B, i.e., when B is not a strong competitor to A. In this case, an increase in s can render A so complacent (setting a very high monetization level) that the *total* demand (sheep and eagles combined) for firm A decreases for given levels of innovation. In such a case, the loss in the demand through which the innovation is monetized (note the Δv in the equilibrium monetization level in Lemma 2) lowers innovation incentives for A.[12] In reverse, as A is fighting less for eagles, it is easier to attract eagles for B, which provides it with a higher innovation incentive, everything else being equal. This explains why innovation incentives may be reversed (higher

[12]Mathematically, this means that $\frac{\partial p_A}{\partial v_A}\frac{\partial D_A}{\partial s} < 0$ with $\frac{\partial p_A}{\partial v_A} > 0$ and $\frac{\partial D_A}{\partial s} < 0$.

for the non-default firm and lower for the default firm) when network effects are low, and B has low market strength.

4.2 Choice of Default and Impact on Consumer Surplus

Policymakers regulating digital markets are particularly concerned with how policy interventions affect consumer surplus. To investigate this thoroughly, we compare how the default setting ($s > 0, c > 0$) affects consumer surplus (and depending on which firm is the default), relative to no default ($s = 0, c = 0$). Generally, consumer surplus is given as the sum of the (expected) utility of eagle and sheep users, weighted by the relative mass of these two user groups. Formally,

$$(A \textit{ is default}) : CS = s \int_0^1 u_A(x)dx + (1-s)\left(\int_0^{\frac{D_{A,eagles}}{(1-s)}} u_A(x)dx + \int_{\frac{D_{A,eagles}}{(1-s)}}^1 (u_B(x)-c)dx\right). \tag{13a}$$

$$(\textit{no default}) : CS_0 = \int_0^{D_{A,eagles|_{s=0,c=0}}} u_A(x)dx + \int_{D_{A,eagles|_{s=0,c=0}}}^1 u_B(x)dx. \tag{13b}$$

Prior results (Corollary 1 and Proposition 1) present a mixed picture, as the default tends to increase both the innovation and monetization levels of A, and reduce those of B. In addition, the default also changes the market shares of A and B, i.e., the composition of the user groups which are affected differently by the default. Further, assigning the default to the superior firm (i.e., when $\Delta\beta > 0$) tends to widen the competitive gap between firms and steers the market towards one dominant firm, while the converse narrows this gap and may even reverse market dominance. Which scenario better serves consumers? While, in general, market concentration harms consumer welfare, the calculus becomes more complex when innovation incentives are considered and strong network effects are present (as covered by our analysis). Therefore, first consider the case where network effects are strong. Careful analysis of Eq. 13a–Eq.13b yields the following insights.

Proposition 2 (Consumer Surplus Under Strong Network Effects)**.** *Under strong network effects, allowing a preset default can improve consumer surplus, particularly when assigned to the better firm ($\Delta\beta > \frac{2(9\alpha-2m)(3\alpha-m)}{9\alpha}$)* ***and*** *when preset defaults are powerful (high s, c*

combination); otherwise, if the power of default is weak, or if the default is assigned to the (much) weaker firm ($\Delta\beta < \frac{2(9\alpha-2m)(3\alpha-m)}{9\alpha}$), the default harms consumer surplus.

Incremental consumer surplus under preset defaults relative to no defaults (under strong network effects)

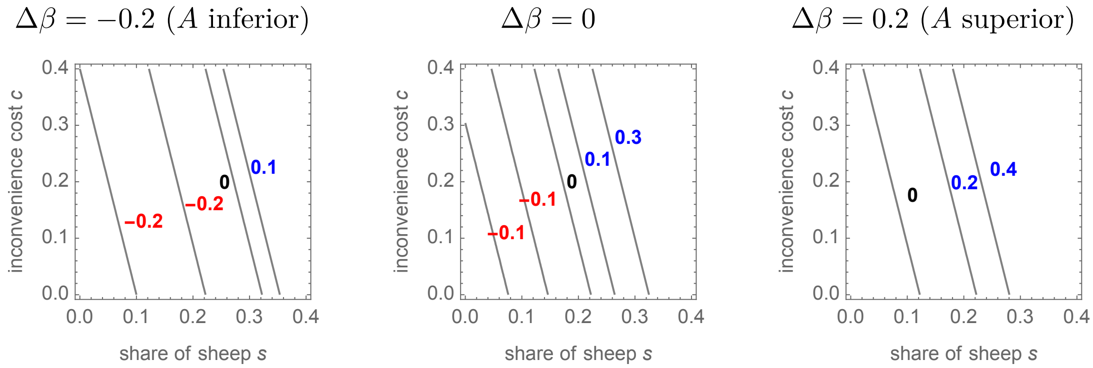


Figure 7: Increment in *consumer surplus* relative to the case without default, under *strong network effects*. All points on a contour have the same increment. Red (blue) indicates lower (higher) surplus than without default. The other parameters are $\alpha = 2$ and $m = 7$.

Fig. 7 visually confirms the observation in Proposition 2 that consumer surplus is more positive when the default is assigned to the superior firm (right panel), and increases with s and c. The result provides insight with respect to the ongoing debates and lawsuits around preset defaults for search engines, and in particular the case against Google for paying Apple (and other firms) to secure the default search engine position on (in case of Apple) iPhones. Crucially, the result suggests that preset defaults were ultimately in consumer interest although they did perpetuate dominance of Google Search and enabled Google to have higher quality (through more data and learning) and more ads (more monetization). This statement is premised on three plausibly true factors: i) Google was already the better search engine, ii) the search industry has significant network effects (see, e.g., Krämer and Schnurr (2021); Prüfer and Schottmüller (2021); Australian Competition & Consumer Commission (2021, 2024)), and iii) the preset default was influential on consumers' choice, because several users are either sheep-like users (and simply keep the default setting) or are deterred from switching due to high inconvenience cost.

The crucial mechanism behind the result is that preset defaults reduce the *a priori* uncertainty in market outcomes that occurs under strong network effects because the market can tip towards either firm (as former Google CEO Eric Schmidt put it: "competition is just one click away"), and consumers face a coordination problem regarding which search engine to patronize. In this environment, preset default can lead the winner to invest more in quality because they increase the likelihood of it receiving a favorable tipping outcome. While this tends to pick the market winner early on, if the "right" firm is selected early on, the benefits of increased innovation can outweigh the costs of higher monetization for consumers. However, our results also suggest that this positive outcome for consumers only arises when the default is indeed powerful enough and can consequentially steer consumers' choice, thus effectively mitigating the consumers' coordination problem and market uncertainty. For example, a high s implies that fewer consumers (eagles) face a potential cost of switching out of the default, making coordination easlier. In reverse, if the power of the default is small (e.g., if s is small but not zero), one bad outcome that could occur is that network effects become fragmented, as eagles go to B, but sheep remain with the default A. When network effects are strong, everything else being equal consumer utility is maximized when all consumers use the same search engine. Policy proposals that aim at reducing the power of defaults, but do not eliminate default settings, may therefore be misguided.

When network effects are weak, the effect of preset default on consumer surplus is somewhat different (see Fig. 8), owing to the differences in how the default impacts monetization and innovation highlighted in Section 4.1. This is mainly due to the different impact of sheep-like users on the equilibrium outcome. Recall that under weak network effects, a larger share of sheep-like users s induces *both* search engines, the default and the non-default firm, to increase monetization, which ultimately hurts consumers. Especially when the preset default guarantees the default firm a high share of sheep, while at the same time the rival is weak (e.g., due to A having a superior product), the complacency effect is dominant, inducing the default firm to innovate less. In this worst-case scenario, consumers of the default firm receive higher monetization *and* lower innovation level by the default firm, rendering a powerful default (s is large) harmful for consumer surplus overall. Nevertheless, we find that also under weak

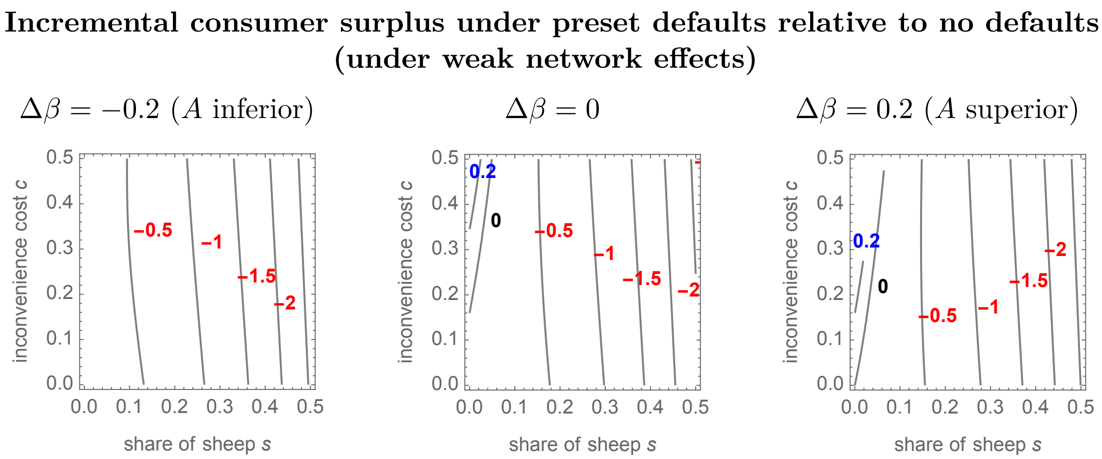


Figure 8: Increment in *consumer surplus* relative to the case without default, under *weak network effects*. All points on a contour have the same increment. Red (blue) indicates lower (higher) surplus than without default. The other parameters are $\alpha = 1.2$, $t = 2$, and $m = 8$.

network effects, consumers can be better off in the presence of a preset default when s is relatively low *and* the designated firm is sufficently superior, as it stimulates the default firm to innovate more, and the non-default form to monetize less.

Proposition 3 (Consumer surplus under weak network effects)**.** *When individual preferences are sufficiently strong relative to network effects, preset defaults reduce consumer surplus unless only a few users blindly follow the default (small s)* **and** *the designated firm is superior or not too inferior ($\Delta\beta > \frac{(9(t-\alpha)-2m)^2}{9t} - \frac{1}{2}c$).*

Taken together, Propositions 2 and 3 underline that economic consequences of preset defaults are more benign for products with strong network effects than for traditional goods with no (or weak) network effects. This is notable because the legal and policy arguments against preset defaults are primarily made in the context of digital goods with network effects. For such goods, we find that preset defaults are not necessarily harmful to consumers, and can even improve consumer surplus. Moreover, the constellations of product and market characteristics which lead to positive vs. negative impact on consumers depend on whether network effects are weak vs. strong. Hence, our results warn against a one-size-fits-all outright ban of preset defaults, and call for a more targeted approach, assessing carefully the environment in which preset defaults are used (strong vs. weak network effects) and how powerful the default is in guiding users' choice and preventing switching. Finally, because the impact on consumer surplus depends on which firm is awarded the default setting, Propositions 2 and 3 motivate the question: If the preset default is assigned to one of the firms, do consumers benefit more if the preset default is assigned to the superior firm, or the inferior firm?

Corollary 2 (Consumer surplus and default assignment)**.** *Consumer surplus is always higher if the preset default is assigned to the superior firm rather than to the inferior firm, regardless of network effects.*

5 Implications and Conclusion

Preset defaults, exploitation of consumer biases, and intentional consumer steering are common phenomena in digital platform ecosystems. Motivated by the ongoing antitrust case of the United States vs. Google, which centers around the power of default effects in the search engine market, we investigate the impact of defaults on competition and innovation in the context of search engines.

Our findings indicate that the economic effects of defaults on search engines' competition intensity and innovation incentives are more complex and surprisingly nuanced. We find that the firm that benefits from the default always increases its monetization level. By contrast, holding innovation levels constant, the rival firm may increase or decrease its monetization level, depending on parameters. In the context of advertisement-funded search engines, this would mean that the default search engine (Google), but potentially also Google's rivals (e.g., Bing), are expected to show more sponsored search results (relative to organic search results) due to the fact that Google is set as the default on all dominant browsers and mobile operating systems. This shift is consistent with the empirical evidence; formerly, when Google started, the results page featured "ten blue links" (almost only organic search results), whereas today the first page may be filled almost entirely with sponsored search results (Fowler, 2020).

On the crucial question of whether preset defaults are harmful to consumers, we find that the outcome depends crucially on the market environment (strong vs. weak network effects) and the power of the default. In reverse, this means that our results reveal a trade-off for policymakers that seek to diminish the power of defaults which steer consumers to already dominant platforms. Besides the antitrust case against Google in the US, preset defaults have already been scrutinized by policymakers in other jurisdictions, such as the EU, UK and Australia. Below, we interpret several of these policy actions in terms of our model results.

In the EU, the Digital Markets Act (DMA) demands that dominant operators show a *choice screen* to users, where they can easily select their preferred search engines from a list of competing services.[13] Similar proposals are made by the UK's Competition and Markets Authority (2020) and the Australian Competition & Consumer Commission (2021, 2024). Previously, such a mechanism has been implemented by Google for Android smartphones in Europe in response to an antitrust decision by the European Commission (Decarolis et al., 2023).[14] Within our model, the use of the choice screen can be thought of as having no default ($c = s = 0$), as the choice screen forces all users to make an active decision, and the cost of each option is identical (and negligible). Our model highlights that such an intervention can make consumers' worse off, because it curbs innovation incentives of the default firm, especially when network effects are strong.

Alternatively, an intervention may target only a particular (dominant) firm from *acquiring the default position*. For example, part of the proposed remedy in *U.S. v. Google* includes preventing Google from making payments to third parties to acquire the default position.[15] This is also a suggested remedy in the UK and Australia. There are different possibilities on how the default position will be allocated. First, the operator may still be allowed to unilaterally choose the dominant search engine as the default without payment. In this case, nothing within the scope of our model changes. Second, the operator may decide not to set any default, but implement a choice screen or similar. This would have the same implications as discussed above. Third, the default position may be given to a rival. If the rival has a superior product and becomes the designated firm, then this is indeed welfare improving for consumers (see Corollary 2); however if the rival has a (much) inferior product, then allocating it the default makes consumers worse off.

A different provision in the DMA requires that the gatekeepers must allow a downloaded

[13] Digital Markets Act, art 6(3).

[14] *Google Android* (Case AT.40099) Commission Decision of 18 July 2018.

[15] Plaintiffs' Initial Proposed Final Judgment, United States v. Google LLC, No. 1:20-cv-03010 (D.D.C. Aug 5, 2024).

third-party software application to *prompt users* to decide whether to set it as the default.[16] While this provision would not entice users to actively consider alternative products, it would be more convenient to switch to an alternative product for users who wish to do so, comparable with a reduction in c (while s is unaffected). On the one hand, this policy intervention should indeed increase competition (reduce monetization level), but it would also decrease innovation by the designated platform; however, on the other hand it also means that rival platforms tend to increase its monetization and innovation levels.

Finally, the DMA demands that a dominant search engine *shares 'click-and-query' data* with its rivals, and similar proposals have been put forth by the UK and Australian competition authorities. In this way, the data-driven network effects can be shared with the rival. Overall, this reduces the importance of network effects and consumers' individual preferences become relatively more important. In our model, this compares to moving from a scenario of strong network effects to one of weak network effects. As our analysis has shown, preset defaults tend to be more harmful when network effects are weak. Hence, when the designated search engine is required to share data with a rival, choice screens (no default) are more likely to lead to better outcomes for consumers.

Although we have framed our model in the context of competition between search engines, the insights of our framework should indeed apply more generally to competing digital platforms, when an operator (such as browser or operating system) has the ability to steer consumers toward one of the platforms. Examples of such settings include competing music streaming apps (e.g., Spotify and Apple Music), where one app is vertically integrated with the device manufacturer (Apple) that has the ability to steer users towards its own service. Additionally, video streaming services like Netflix and Amazon Prime illustrate another scenario where default settings on smart TVs and devices could influence consumer choice. Finally, and looking ahead, we expect that preset defaults will emerge as a weapon in the artificial intelligence wars (especially, chatbots and language models, which are being widely adopted and placed on smart devices), and our findings can pro-actively inform policy makers in this important arena.

[16]Digital Markets Act, art 6(4).

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A Omitted proofs

Proof of Lemma 1. In stage 2, the firms A and B simultaneously solves $\max_{p_A \geq 0}$ (7a) and $\max_{p_B \geq 0}$ (7b), respectively. In an interior equilibrium, the best responses based on the first-order conditions are

$$p_A^{BR}(p_B) = \frac{\alpha + 2\alpha s + c + \Delta\beta + \Delta v + p_B}{2}$$
$$p_B = \frac{\alpha - 2\alpha s - c - \Delta\beta - \Delta v + p_A}{2}.$$

Solving the system of equations yield Eq. (8a) and Eq. (8b).

In stage 1, the firms solves $\max_{v_A}$ (7a) and $\max_{v_B}$ (7b), anticipating the equilibrium monetization levels (8a) and (8b) in stage 2. The best responses based on the first-order conditions are

$$v_A = \frac{3\alpha + 2\alpha s + c + \Delta\beta - v_B}{9\alpha - m}$$
$$v_A = \frac{3\alpha - 2\alpha s - c - \Delta\beta - v_A}{9\alpha - m}.$$

Solving the system of equations yield Eq. (9a) and Eq. (9b). Note that the equilibrium requires that the equilibrium monetization and innovation levels satisfy $(\Delta p^*(v_A^*, v_B^*) - \Delta v^*) - c \in [\alpha(2s-1), \alpha]$, ensuring that $\mathbf{pr}_i \leq 1$. This is ensured for $s \leq \bar{s} = \frac{3(3\alpha - c - \Delta\beta) - 2m}{6\alpha}$.

□

Proof of Lemma 2. In stage 2, the firms A and B simultaneously solves $\max_{p_A \geq 0}$ (10a) and $\max_{p_B \geq 0}$ (10b), respectively.

We focus on the case that both firms have positive demand from eagle users in equilibrium. A necessary condition for this is $\Delta v < \frac{\psi_A + 2\psi_B - s\psi_B}{1-s}$. In this case, we have

In an equilibrium where both firms have positive demand from eagle users, the first-order conditions for the firms' profit maximization problems are

$$p_A^* = \frac{1}{2}\left(p_B^* + \Delta v + \frac{\psi_A + s\psi_B}{1-s}\right) \quad \text{and} \quad p_B^* = \frac{1}{2}\left(p_A^* - \Delta v + \psi_B\right).$$

Solving the system of equations yields

$$p_A^* = \frac{1}{3}\left(\frac{2\psi_A + \psi_B + s\psi_B}{1-s} + \Delta v\right) \quad \text{and} \quad p_B^* = \frac{1}{3}\left(\frac{\psi_A + 2\psi_B - s\psi_B}{1-s} - \Delta v\right).$$

Substituting ψ_A and ψ_B yield Eq. (11a) and Eq. (11b).

The equilibrium where both firms have positive demand from eagle users exists only if

$$-\frac{2\psi_A - 3s\psi_A + \psi_B - 2s\psi_B}{1-s} < \Delta v < \frac{\psi_A + 2\psi_B - s\psi_B}{1-s}. \tag{14}$$

In stage 1, the firms solves $\max_{v_A \geq 0}$ (10a) and $\max_{v_B \geq 0}$ (10b), anticipating the equilibrium monetization levels (11a) and (11b) in stage 2. In an equilibrium where both firms will have positive demand from eagle users in stage 2, the best responses based on the first-order conditions are

$$v_A^{BR}(v_B) = \frac{2m(2\psi_A + \psi_B + s\psi_B - (1-s)v_B)}{9(\psi_A + \psi_B) - 2m(1-s)}$$
$$v_B^{BR}(v_A) = \frac{2m(\psi_A + 2\psi_B - s\psi_B - (1-s)v_B)}{9(\psi_A + \psi_B) - 2m(1-s)}$$

Solving the system of equations yields

$$v_A^* = \frac{2m}{3}\left[\frac{3(2\psi_A + \psi_B + s\psi_B) - 2m(1-s)}{9(\psi_A + \psi_B) - 4m(1-s)}\right]$$
$$v_B^* = \frac{2m}{3}\left[\frac{3(\psi_A + 2\psi_B - s\psi_B) - 2m(1-s)}{9(\psi_A + \psi_B) - 4m(1-s)}\right].$$

Substituting ψ_A and ψ_B yields Eq. (12a) and Eq. (12b). Inequality (14) is satisfied at under the above values of v_A^* and v_B^* only if

$$-\left(\frac{3-5s}{1-s}\right)t + 3\alpha(1-2s) - c + \frac{2}{3}m(1-2s) < \ \Delta\beta \ < \left(\frac{3-s}{1-s}\right)t - \alpha + c - \frac{2m}{3}.$$

□

Proof of Corollary 1. Under strong network effects, the partial derivatives of the equilibrium monetization levels with respect to s and c are

$$\frac{\partial p_A^*}{\partial s} = -\frac{\partial p_B^*}{\partial s} = \frac{2}{3}\alpha$$
$$\frac{\partial p_A^*}{\partial c} = -\frac{\partial p_B^*}{\partial c} = \frac{1}{3}.$$

Given that $\alpha > 0$, it follows that p_A^* is increasing in s and c, while p_B^* is decreasing in s and c.

Under weak network effects, the partial derivatives of the equilibrium monetization levels with respect to s are

$$\frac{\partial p_A^*}{\partial s} = \frac{4t}{3(1-s)^2}$$
$$\frac{\partial p_B^*}{\partial s} = \frac{2t}{3(1-s)^2}$$
$$\frac{\partial p_A^*}{\partial c} = -\frac{\partial p_B^*}{\partial c} = \frac{1}{3}.$$

With $t > 0$, the monetization levels for both firms are increasing in s, but p_A^* is increasing in c while p_B^* is decreasing in c. □

Proof of Proposition 1. Under strong network effects, the partial derivatives of the equilibrium innovation levels are with respect to s and c are

$$\frac{\partial v_A^*}{\partial s} = -\frac{\partial v_B^*}{\partial s} = \frac{2m\alpha}{9\alpha - 2m}$$
$$\frac{\partial v_A^*}{\partial c} = -\frac{\partial v_B^*}{\partial c} = \frac{m}{9\alpha - 2m}.$$

Given the assumption $9|\psi_A + \psi_B| = 9 \cdot 2\alpha(1-s) > 4m(1-s)$, or equivalently $9\alpha - 2m > 0$, it follows that v_A^* is increasing in s and c, while v_B^* is decreasing in s and c.

Under weak network effects, the partial derivatives of the equilibrium innovation levels are with respect to s and c are

$$\frac{\partial v_A^*}{\partial s} = \frac{4mt(9\psi_B - 2m)}{[9(\psi_A + \psi_B) - 4m(1-s)]^2} = -\frac{\partial v_B^*}{\partial s}$$
$$\frac{\partial v_A^*}{\partial c} = \frac{2m(1-s)}{9(\psi_A + \psi_B) - 4m(1-s)} = -\frac{\partial v_B^*}{\partial c} > 0.$$

With $s < 1$ and $9(\psi_A + \psi_B) > 4m$, it follows that $\frac{\partial v_A^*}{\partial c} > 0$. With $m > 0$ and $t > 0$, we have that $\frac{\partial v_A^*}{\partial s} > 0$ if $9\psi_B - 2m > 0$. □

Proof of Proposition 2. Let CS be the consumer surplus with the default and CS_0 is the consumer surplus without default ($c = 0, s = 0$) in case of strong network effects. We have $CS > CS_0$ if

$$s > \tilde{s} = \frac{4m^2 - 9\alpha(c + 2\Delta\beta + 4m - \alpha)}{18\alpha^2}$$

Notice that the threshold $\tilde{s}$ is decreasing in c. Thus a higher inconvenience cost c makes it more likely that the consumer surplus is higher with default compared to no default (and vice-versa for s), leading to the conclusion that a strong default (high s or high c, or both) are more likely lead to increased consumer surplus. Further notice that $\tilde{s}$ is decreasing in $\Delta\beta = \beta_A - \beta_B$. Thus, the higher the baseline utility offered by the designated firm, β_A, the more likely it is that the default yields a higher consumer surplus compared to no default.

However, we need to ensure that the threshold $\tilde{s}$ lies within the feasible parameter range, as otherwise, consumer surplus can never be higher with a default. Specifically, we we need to ensure that $s \leq \bar{s} = \frac{3(3\alpha - c - \Delta\beta) - 2m}{6\alpha}$, which guarantees that $\mathbf{pr}_A \leq 1$ in equilibrium. Taken together, we obtain a region $\tilde{s} < s < \bar{s}$ in which consumer surplus is higher with the default setting. The region may or may not exist. It does not exist for $\Delta\beta < \frac{2(9\alpha - 2m)(3\alpha - m)}{9\alpha}$, meaning that when the designated firm's superiority is below this threshold, consumer surplus can never be higher with the default, irrespective of the values of s and c. In reverse, when $\Delta\beta$ is below this threshold, there exist values for s and c such that the default leads to higher consumer surplus. □

Proof of Proposition 3. First suppose $s = 0$, then consumer surplus under the default (with $c \geq 0$) is greater than the consumer surplus without the default ($c = s = 0$) if

$$c > \overline{c}_\alpha(0) \equiv 2\left(\frac{(9t - (9\alpha + 2m))^2}{9t} - \Delta\beta\right).$$

Notice that the threshold is decreasing in α. Hence, at $s = 0$, stronger network effects make it more likely that the condition is satisfied, i.e., that the default increases consumer surplus.

The corresponding condition for $s > 0$ is

$$c > \overline{c}_\alpha(s) \equiv \frac{(9\alpha + 2m)^2(1-s)(A+1)}{9t} - 2(9\alpha + 2m)(A+1) - \frac{t(s - 9(A+1))}{1-s} - \Delta\beta$$

with

$$A = \sqrt{\frac{27(s(3s-17)+18)t^2(9\alpha+2m)^2 + 972(s-3)t^3(9\alpha+2m) - 18(2-s)(1-s)t(9\alpha+2m)^3}{(9t-(9\alpha+2m))^2(9t-(1-s)(9\alpha+2m))^2}} + \sqrt{\frac{(1-s)^2(9\alpha+2m)^4 + 81\Delta\beta^2(1-s)t^2 - 18\Delta\beta(1-s)t(9t-(9\alpha+2m))^2 + 2187(s+3)t^4}{(9t-(9\alpha+2m))^2(9t-(1-s)(9\alpha+2m))^2}}$$

Note that $A > 0$ given our assumptions under weak network effects. It can be shown analytically that $\overline{c}_\alpha(s) > \overline{c}_\alpha(0)$ for $t > \frac{1}{6}\sqrt{\frac{5}{11}}(9\alpha + 2m)$.[17] Note that this condition on t is only slightly stricter than the condition $t > \frac{1}{9}(9\alpha + 2m)$ which defines the weak network effects case. Thus, when users' preferences are sufficiently strong relative to network effects, $\overline{c}_\alpha(0)$ represents a lower bound on c for all values of s. This means, for any $c < \overline{c}_\alpha(0)$, consumer surplus can never be higher with the default than without the default, irrespective of s. This is the condition provided in the proposition. Further, because $\overline{c}_\alpha(s) > \overline{c}_\alpha(0)$, this means that for $s > 0$ also higher levels of c can lead to higher consumer surplus with the default. However, for a given level of $c > \overline{c}_\alpha(s)$, s cannot be too large in order for the default to lead to higher consumer surplus. This is shown for a numerical example in Fig. 9 for different levels of α.

□

Proof of Corollary 2. Consider firm 1 and firm 2, with $\beta_1 > \beta_2$. Let CS_1^w and CS_2^w denote the consumer surplus under weak network effects, when firm 1 and firm 2 is assigned the default, respectively. Note that we have $\Delta\beta > 0$ if firm 1 is the default, and $\Delta\beta < 0$ if firm 2 is the default. The difference in consumer surplus is given by

$$CS_1^w - CS_2^w = (\beta_1 - \beta_2)\cdot \frac{(9\alpha(1-s))^2 + (2m(1-s))^2 - 36mt(1-s) - 18\alpha(1-s)(9t - 2m(1-s)) + 9t(9t + st - (1-s)c)}{(9(t-(1-s)\alpha) - 2m(1-s))^2}$$

The difference is always positive given our assumptions if $\beta_1 > \beta_2$.

[17] Details are available from the authors upon request.

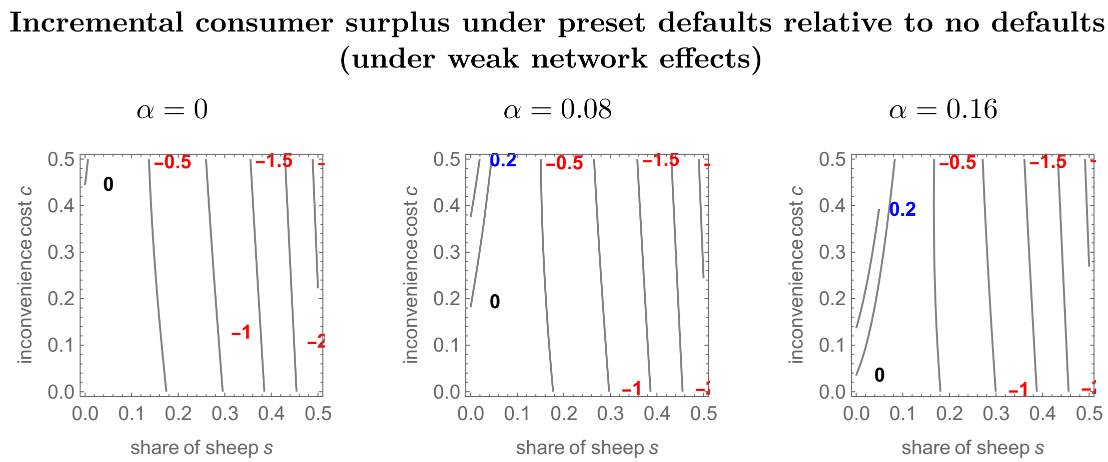

Figure 9: The impact of preset defaults on *consumer surplus* under *weak network effects*, illustrated for $t = 2$, $m = 8$, $\Delta\beta = 0$.

Similarly, let CS_1^s and CS_2^s be the consumer surplus under strong network effects, when firm 1 and firm 2 is assigned the default, respectively. The difference in consumer surplus is given by

$$CS_1^s - CS_2^s = (\beta_1 - \beta_2) \cdot \frac{9\alpha^2(9+4s) + 4m^2 + 18\alpha(c-2m)}{(9\alpha - 2m)^2}$$

Again, given our assumptions, the difference is always positive if $\beta_1 > \beta_2$. □

B Users not directly affected by the default

In this section, we consider what happens when the operator who sets the preset default does not control the access of the entire user base, that is $\lambda < 1$. First, we will show that in the case of weak network effects, the resulting outcome when we allow for a fraction $1 - \lambda$ of outside users would be as if the power of the default became weaker, i.e., the parameters s and c are adjusted downward.

B.1 Weak network effects

In the case of weak network effects, we can show that the resulting outcome when we allow for a fraction $1 - \lambda$ of outside users would be as if the power of the default became weaker, i.e., the parameters s and c are adjusted downward.

Let n_i^e denote the users' anticipated demand for firm i. In the baseline model ($\lambda = 1$), the eagle users have the utility functions in (1a), and the indifferent user, before resolving for the fulfilled expectations equilibrium, is located at

$$\hat{x} = \frac{\Delta v - \Delta p + t + \alpha_A n_A^e - \alpha_B n_B^e + c}{2t} \tag{15}$$

and the demand for the default firm A if $\hat{x}$ is interior is

$$n_A = s + (1-s)\left[\frac{\Delta v - \Delta p + t + \alpha(n_A^e - n_B^e) + c + \Delta\beta}{2t}\right]. \tag{16}$$

If there exist outside users, the indifferent user for the eagles remains the same as in (15), whereas the indifferent user for the outside users is located at

$$\hat{x}_o = \frac{\Delta v - \Delta p + t + \alpha(n_A^e - n_B^e) + \Delta\beta}{2t}$$

and the demand for the default firm A becomes $n_A = \lambda[s + (1-s)\hat{x}] + (1-\lambda)\hat{x}_o$, if both $\hat{x}$ and $\hat{x}'$ are interior in $(0,1)$. Substituting $\hat{x}$ and $\hat{x}_o$ and rearranging yields

$$n_A = \lambda s + (1-\lambda s)\left[\frac{\Delta v - \Delta p + t + \alpha(n_A^e - n_B^e) + \Delta\beta + \left(\frac{\lambda - \lambda s}{1-\lambda s}\right)c}{2t}\right]. \tag{17}$$

Comparing (16) and (17), we see that the (unresolved) demand is equivalent to the baseline model where the share of passive sheep-like users is $s' \equiv \lambda s \leq s$ and the inconvenience cost $c' \equiv \left(\frac{\lambda - \lambda s}{1-\lambda s}\right) c \leq c$. That is, the presence of outside users acts like a reduction in s and c.

B.2 Strong network effects

The case of strong network effects is more complicated. As with the baseline model with $\lambda = 1$, all users in a particular group must make the same choice, as any equilibrium in which this is not the case would be unstable.

An equilibrium where all users choose A exists if an individual outside user has no incentive

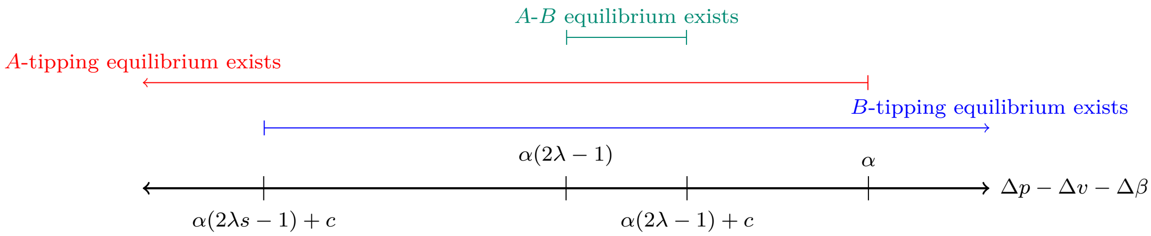

Figure 10: The region of $\Delta p - \Delta v - \Delta\beta$ with an equilibrium where all users choose A, an equilibrium where all eagle and outside users choose B, and an equilibrium where all eagle users choose A while outside users choose B ("A-B-equilibrium")

to switch to B, that is,

$$\beta_A + v_A + \alpha - p_A \geq \beta_B + v_B - p_B$$
$$\iff \Delta p - \Delta v - \Delta\beta \leq \alpha$$

Note that this also implies that an eagle user will not want to switch to B.

Conversely, an equilibrium where all eagle users and outside users choose B exists if an individual eagle user does not want to switch to A.

$$\beta_A + v_A + \alpha\lambda s - p_A \leq \beta_B + v_B + \alpha(1 - \lambda s) - p_B - c$$
$$\Delta p - \Delta v - \Delta\beta \leq \alpha(2\lambda s - 1) + c$$

In addition to the two possible equilibria, a third equilibrium can exist where all users within the operator's control (sheep and eagles) choose the default firm A, whereas the users outside the operator's control choose B. This is possible if

$$\beta_B + v_B(1 - \lambda) - p_B - c \leq \beta_A + v_A + \alpha\lambda - p_A \leq \beta_B + v_B(1 - \lambda) - p_B$$
$$\iff \alpha(2\lambda - 1) \leq \Delta p - \Delta v - \Delta\beta \leq \alpha(2\lambda - 1) + c$$

Note that it would not be possible for an equilibrium in which eagle users choose B while the outside users choose A.

Next consider the impact of outside users on the impact of c. If c is not too large, the existence of different types of equilibria at a given level of $\Delta p - \Delta v - \Delta\beta$ is shown in Figure 10.

Suppose for now that the $A - B$ equilibrium, in which the eagle users and the outside users choose differently, is ruled out, so that the only possible equilibria are the A-tipping and B-tipping equilibrium, as in the baseline model. We can then construct a similar probability function $\mathbf{pr}_A$ as in the baseline model, as follows:

$$\mathbf{pr}_A(\Delta v, \Delta p, \Delta\beta) = \begin{cases} 1 & \text{if } \Delta p - \Delta v - \Delta\beta \leq \alpha(2\lambda s - 1) + c \\ 0 & \text{if } \Delta p - \Delta v - \Delta\beta \geq \alpha \\ \frac{\Delta v - \Delta p - \Delta\beta + \alpha}{(1-\lambda s)(2\alpha) - c} & \text{otherwise} \end{cases}$$

It is immediately evident that the probability that A wins all users at a given $\Delta p - \Delta v - \Delta\beta$ increases with λ, and is maximized when $\lambda = 1$, which we assume in the baseline model. A lower λ therefore reduces the power of default. Furthermore, if we now add to the consideration that for $\lambda < 1$ an additional equilibrium can arise in which the outsiders choose B, rather than A, at that this equilibrium is chosen with a positive probability, then the expected demand for A would decrease even further compared to the baseline model. This shows that the power of the default is weakened, as the share of users that are affected by the default is reduced.