Content-hosting platforms: discovery, membership, or both?*

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Abstract

Our model classifies platforms in the "creator economy"—e.g. Youtube, Patreon, and Twitch—into three business models: pure discovery (helping consumers search for creators); pure membership (enabling direct creator-consumer monetization); and hybrid (combining both). Creators respond to platforms' decisions by choosing their content design along a broad-niche spectrum, trading off between viewership size and per-viewer monetization. With a monopoly platform, moving from pure discovery to hybrid increases profit while inducing a more niche content design; moving from pure membership to hybrid can reduce platform profit while inducing broader content design. We show how intense platform competition reverses these trade-offs.

JEL classification: D26, D4, L2, L5

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1 Introduction

The "creator economy" is an industry that has an estimated global worth of $104 billion as of 2022 with 50 million independent content creators (The Economist 2021). In this economy, prominent platforms such as YouTube, Facebook, Instagram, Spotify, Snap, and Twitter (known as X since July 2023) have traditionally operated as "discovery portals": they enable consumers to discover media content produced by third-party creators. Doing so allows the platforms to attract consumer attention, which they and creators can sell to advertisers (Evans 2019). As online content creation has matured as an industry, firms like Patreon, Subbable, and Substack have been established as "membership portals". These portals provide infrastructure for individual creators to monetize their direct relationships with viewers or readers through, e.g., subscriptions to each creator's channel and sales of exclusive content (see Figure 1 below for an example). Membership portals then generate revenues by taking a commission on these direct transactions.[1]

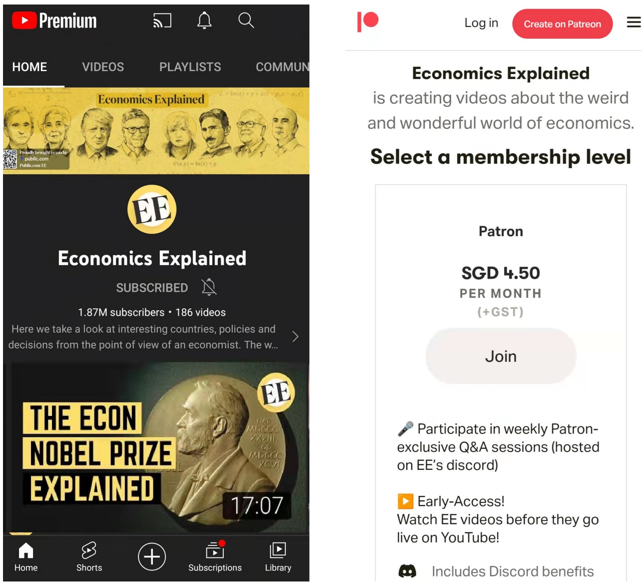

Figure 1: Creators often multi-home on both discovery and membership portals. The left panel of this figure shows the Youtube channel of a creator, "Economics Explained", where it publicly broadcasts most of its content to grow its audience. The right panel shows the creator's Patreon page for viewers to pay and subscribe for additional perks.

However, these business models are not mutually exclusive. Several platforms operate in a "hybrid mode" that combines the functions of discovery and membership portals. For example, Twitch and TikTok allow consumers to discover and watch live-streaming sessions and short

[1] Membership portals are distinct from the classic "Pay TV" models adopted by, e.g., Netflix and Disney+. In a Pay TV model, consumers pay a subscription fee to the firm as a whole to access the content that the firm acquires either by its own internal production or through vertical relationships with production firms. In contrast, in a membership portal consumers directly pay each content creator in exchange for benefits supplied by the creators. These creators are largely independent and do not sell their content to the portal. The distinction is reminiscent of the reseller versus marketplace comparison (Hagiu and Wright 2015).

videos, and both incorporate ads either before or in the middle of the offered content. At the same time, dedicated followers of each creator can choose to donate or subscribe to the creator to receive exclusive benefits (e.g., custom chat emotes and exclusive streaming events) through integrated infrastructure on these platforms. Another example of hybrid modes is Bilibili, the counterpart of Youtube in China that also allows creators to receive donations and sell courses.

More recently, several platforms that have traditionally operated as pure discovery portals have shifted to operating in hybrid mode. In 2018, YouTube and Facebook rolled out "channel membership" and "creator membership", which allows selected creators to offer monthly membership plans to their fans that provide access to various exclusive perks. In 2021, Twitter acquired a Substack-like newsletter startup and launched a membership feature called "Super Follows". The The Economist (2021) noted that

> *"...Twitter was in danger of becoming a promotional tool for Substack writers."*

and described Twitter's move as "trying to beat both (platforms) at their own game." Meanwhile, even though a few emerging platforms that launched as membership portals have subsequently introduced content discovery features (e.g., Playbook), several others have deliberately chosen not to do so (e.g., Patreon) or have removed such features after introducing them (e.g., Teachable). Table 1 below provides a summary.

	Functions	Example firms	Monetization strategies of firms
Pure discovery	Enable or facilitate discovery of content produced by creators	YouTube (pre-2018), Facebook (pre-2018), Twitter (pre-2021), Spotify, Snap, Instagram, Nebula, Skillshare, Medium	Pre-roll and mid-roll ads in videos, ads between posts and content feeds[2]
Pure membership	Enable or facilitate transactions between creators and consumers	Patreon, Subbable, Teachable, Substack, Playbook	Transaction commissions on viewer donations, subscriptions to individual creators, and purchase of exclusive content
Hybrid	Both functions above	YouTube (post-2018), Facebook (post-2018), Twitter (post-2021), Twitch, TikTok, Bilibili	Ads in streaming sessions and videos, transaction commission on subscriptions to individual creators and purchases of games and virtual goods

Table 1: Example businesses for the three modes of operation

This article analyzes the implications of platforms choosing between operating in a pure discovery mode, in a pure membership mode, or in a hybrid mode. At the creator level, how do

[2]Strictly speaking, monetization strategies by Nebula, Skillshare, and Medium do not involve advertisement. Instead, these platforms impose a platform-wide paywall so that consumers have to pay a monthly (platform-wide) subscription fee to access the content, and then the platforms distribute a portion of that revenue to content creators based on the corresponding watch time. We discuss how our model can fit this strategy in Section 6.

changes in platform business modes affect the content creation decisions? At the platform level, what are the trade-offs of going hybrid and how do strategic interactions with rival platforms influence these trade-offs? At the market level, what are the possible equilibrium market structures in the creator economy?

To explore these questions, we develop a model where consumers sequentially search for creators, realize an idiosyncratic match value, and decide whether to become viewers of a creator, whereas creators compete by choosing the "design" of their content. To model content design decisions, we adopt a modified version of Johnson and Myatt (2006): the designs range from "broad" designs that are highly likely to match each consumer's taste but, conditional on a realized match, generate relatively low willingness to pay compared to "niche" designs where the opposite is true. This modeling choice captures the idea that, in our examples above, creators primarily compete through content design rather than solely rely on pricing strategies. Creators' revenue comes in two parts: a fixed benefit from each viewer (e.g., advertising revenue) and revenue from pricing and selling exclusive content (e.g., channel subscriptions, add-on content, and merchandise). Consumers initiate search if and only if the expected surplus is higher than their outside option.

In Sections 3 and 4, we consider a monopoly platform that can include one or both of the following components: (i) a discovery portal and (ii) a membership portal. A discovery portal generates per-viewer ad revenue to the platform while facilitating consumer search. That is, it has partial information on each consumer's idiosyncratic preferences and then truthfully recommends the best search option to the consumer. Meanwhile, a membership portal raises each creator's expected revenue from exclusive content, reflecting that it facilitates transaction convenience between consumers and creators. The platform charges an ad-valorem transaction commission on each unit of exclusive content revenue. We say that the platform is in pure discovery (membership) mode if it operates only a discovery (membership) portal, and in hybrid mode if it operates both portals.

Consistent with the business model choices by firms mentioned above, our first set of results show that it is sometimes unprofitable for a pure membership platform to add a discovery portal, whereas it is always profitable for a pure discovery platform to add a membership portal. The reasons of the results are as follows. Intuitively, adding a discovery portal facilitates search and so always attracts more consumers, but it also induces a "chase-the-algorithm" effect. That is, creators compete for recommendations by adjusting their design broadness. The implication of this effect depends on the search environment. If the effective search cost is large, creators chase the algorithm by raising broadness. This lowers the value of exclusive content, which decreases the platform's profit when transaction commissions are a more important revenue source than advertising. In contrast, if the effective search cost is small, then the reverse is true: creators chase the algorithm by creating more niche content, and the switch to the hybrid mode always increases the platform's profit. Meanwhile, adding the membership portal allows each creator to better extract consumers' (conditional) willingness to pay through its exclusive content pricing. This raises each creator's marginal gain from choosing a niche content design, resulting in a lower design broadness in equilibrium. Still, adding the membership portal always increases the platform's profit because it can fully mitigate any potential losses from the decrease in broadness by appropriate adjusting the transaction commission level (which it has complete freedom to do as monopoly).

In Section 5, we consider how strategic interactions between duopoly platforms influence endogenous business model decisions. When the commission competition between membership portals is weak (e.g., in a competitive bottleneck setup of Armstrong (2006) where consumers are singlehoming and creators are multihoming or when there is strong horizontal differentiation between platforms), we find similar results as in the monopoly benchmark. However, when the commission competition between membership portals is strong (e.g., when both creators and consumers are free to multihome and horizontal differentiation between platforms is weak), the hybrid mode is no longer necessarily more profitable for the platform compared to pure discovery mode. Specifically, whenever the rival platform operates a membership portal, the switch to the hybrid mode creates competition in transaction commissions between the two platforms to attract content creators. The resulting competitive constraint means the platform can no longer freely choose the commission level to mitigate any potential downside of the shift in design, unlike in the monopoly benchmark.

Finally, at the market level, asymmetric business models can arise in equilibrium, with a mixture of a pure discovery platform with either a pure membership platform or a hybrid platform. Such asymmetry arises as long as the commission competition between membership portals is strong, and it reflects platforms' strategic incentive to avoid the spillover from competition in transaction commission to advertising revenue.

2 Related literature

Media platforms and user-generated content. Most of the existing literature on media platforms has focused on two-sided intermediaries between consumers and advertisers (Anderson and Coate 2005; Armstrong 2006; Peitz and Valletti 2008; Crampes, Haritchabalet, and Jullien 2009; Athey, Calvano, and Gans 2018; Anderson and Peitz 2020).[3] We simplify the advertiser side of the market, as we take as given platform's and creators' advertising revenues. Our focus is instead on the side of independent creators who contribute content to media platforms and relate this feature with platforms' choice of business model.

A number of recent works in the economics, strategy, and marketing literatures explore the role of user-generated content on media platforms. Among the issues explored in this branch of the literature are: quality investments by independent news or content contributors (Dellarocas, Katona, and Rand 2013; Jeon and Nasr 2016; De Corniere and Sarvary 2023), user-generated ratings (Luca 2015), exclusive contracts with superstar creators (Carroni, Madio, and Shekhar 2023), user-generated content and endogenous horizontal differentiation among media platforms (Zhang and Sarvary 2015), bias in media provision (Yildirim, Gal-Or, and Geylani 2013), and how the competitive environment on platforms affects the behavior of independent creators or influencers (Iyer and Katona 2016; Fainmesser and Galeotti 2021; Kerkhof 2022; Tudón 2022; Pei and Mayzlin 2022; De Chiara et al. 2022; Abolfathi 2023). These works do not consider the implications of media platforms' choices of business models, platform recommendations, and the emerging trend of creators monetizing their viewers through membership portals. Hua et al. (2022) and Andres, Rossi, and Tremblay (2023) do consider this trend, but these articles focus on the impact of advertiser preferences and toxic content on creator monetization strategies rather than platform business models.

Business models of media platforms. Our work relates to some recent works that analyze media platforms' endogenous choice between two types of business models: a subscription model (or Pay TV) in which the platform raises most (if not all) of its revenue from the consumers, and an ad-funded (or free-to-air) model in which the platform raises most of its revenue from advertisers.[4] Kind, Nilssen, and Sørgard (2009) relate symmetric business model choices to the extent of content

[3] For a textbook treatment on this large literature, see Anderson, Waldfogel, and Strömberg (2016).

[4] In a slightly different vein, a number of contributions focus on intermediaries that connect between buyers and sellers, and compare between business models such as: marketplace, reseller, or a combination of both (Hagiu and Wright 2015; Hagiu, Teh, and Wright 2022), price-dependent profit sharing (Foros, Hagen, and Kind 2009), platform or vertically integrated firm (Hagiu and Wright 2018). These comparisons involve trade-offs such as double marginalization, price coordination in vertical channels, asymmetric costs and information, and moral hazard, which are less prominent in our context of content platforms.

differentiation among media firms. Calvano and Polo (2020) show that asymmetric business models can coexist in broadcasting market even when firms are ex-ante symmetric, reflecting a strong substitutability in firms' advertising quantity decisions. Gal-Or, Geylani, and Yildirim (2012) explore how supplementing advertising with subscription fees affects the extent of media bias. These articles do not consider the emerging business model of membership portals that enable direct transactions between creators and consumers (which is distinct from Pay TV models) and the roles of independent content creators (which are absent in Pay TV model), both of which are the main drivers of our results.[5]

The notable exceptions are the recent contributions by Liu, Yildirim, and Zhang (2022) and Bhargava (2022). Liu, Yildirim, and Zhang (2022) consider a platform that makes content moderation decisions that affects users willingness to participate and their intensity of posting content. Among other things, they show how a monopoly platform's choice between platform-wide subscription and ad-funded models depends crucially on users' utility from posting content. Bhargava (2022) focuses on a monopoly content platform that is ad-financed with endogenous creators' participation and supply decisions. He derives the implications of various platform configuration choices, e.g., tools that lower consumers' distaste for ads and creators' creation costs. Our analysis differs from these in a few respects: we focus on creators' content design decision along a broad-niche spectrum, we consider the equilibrium implications of content recommendations by platforms, and we show that settings of monopoly platform and competing platforms sometimes lead to substantially different insights on the comparison of business models.

Discovery portal and platform governance design. One novelty of our formulation of the discovery mode, which distinguishes it from the ad-funded business model considered in the media literature, is that a discovery portal makes content recommendations to aid consumer search. Thus, our article broadly relates to recent contributions on platform incentives in governance decisions. Casner (2020), Teh (2022), Hagiu and Wright (2023) focus on the role of governance (e.g., consumer search, screening, and information provision) as an instrument that trades off between competition among sellers, gross value generated from transactions, and seller participation. Choi and Jeon (2023) and Madio and Quinn (2021) consider technology adoption and content moderation as tools for a platform to balance between the interests of consumers and advertisers. These articles take as given platform business models and focus on the welfare distortions in platform decisions

[5] Nonetheless, some of our motivating examples (YouTube, Spotify, and Twitch) operate in a freemium model with Pay TV-like subscriptions that can be paid directly to the platform, which allow consumers to avoid ads on the platform. We allow for such platform-wide access pricing by discovery portals in Section 6.

that arise due to the platform's profit-maximization motive. [6]

Membership portals and crowdfunding. In our model, membership portals act as a coordination device to help consumers who like a specific product (in this case a creator's content) agree to fund the creation of that product, which is similar to crowdfunding platforms such as Kickstarter. Our article thus has a loose connection to the crowdfunding literature (Deb, Oery, and Williams 2023; Ellman and Hurkens 2019). Notably however, that literature tends to focus on the mechanism design aspects of one-shot project-based crowdfunding efforts, whereas the business model of membership portals is based around support for content creators who produce content on a continuing basis.

3 Benchmark monopoly model

There is a monopoly platform, a continuum of consumers with mass 1, and a continuum of ex-ante symmetric but differentiated content creators (denoted as set $\mathcal{N}$). The platform can include one or both of the following functionalities in its operation: (i) a discovery portal; (ii) a membership portal.

□ **Creators and consumers.** Each creator $i \in \mathcal{N}$ is characterized by (i) their *exogenous* creator *type* $t_i \in T = \{1, 2, 3, ..., n_0\}$, which can be interpreted as the content category of the creator; and (ii) their *endogenous* creator level content *design* parameterized as $\lambda_i \in [0, 1]$, which can be interpreted as the "channel" or "creator profile" positioning strategy of the creator. Consumers are unit-demand in the sense that they become a viewer of at most one creator, and each consumer j has a specific creator type $t_j \in T$ that she is interested in. The type distribution is uniform: $\Pr(t_i = t) = \Pr(t_j = t) = 1/n_0$ for any $t \in T$.

A creator with type $t_i \neq t_j$ delivers zero utility $u_{ij} = 0$ to consumer j, whereas a creator with type $t_i = t_j$ delivers utility

$$u_{ij} = \left\{ \begin{array}{cc} u(\lambda_i) & \text{with probability } \lambda_i \\ 0 & \text{with probability } 1 - \lambda_i \end{array} \right\}. \tag{1}$$

Here, λ_i is the probability of a match in taste between creator i and consumers: that is, even if creator i's content type t_i fits what the consumer is interested in, there are still idiosyncratic

[6] In a similar manner, Kickstarter or other crowdfunding platforms allow creators to offer tiered benefits to each consumer depending on the amount of fund the consumer pledges. Consumers then decide how much to pledge to that creator and receive the benefits according to what the creator offers at that level of support.

factors that result in a taste mismatch.[7] Meanwhile, $u(\lambda_i)$ is the expected *net utility* of becoming a viewer of creator i (conditioned on a match in taste), which is inclusive of any exclusive content that the consumer may be accessing.[8] Finally, each consumer has an outside option, which is valued at $x_j \in [\underline{x}, \bar{x}]$ and distributed according to a continuously differentiable and log-concave cumulative distribution function (CDF) $G(x_j)$. Denote the density function as $g(x_j)$, where $\lim_{x_j \to \bar{x}} g(x_j) = 0$.

We interpret each creator i's content design λ_i as its degree of "broadness" in its channel positioning, in the spirit of Johnson and Myatt (2006) and Bar-Isaac, Caruana, and Cuñat (2012). A high λ_i corresponds to a "broad" design: the content has mass-market appeal and is likely to match the taste of many consumers but consumers have lower utilities conditional on a match. A low λ_i corresponds to a "niche" design: the creator tailors content to a small group of viewers such that these viewers have higher utility conditional on a match. Reflecting this broad-versus-niche trade-off, we assume the function $u(\lambda_i)$ is weakly decreasing, weakly concave, and continuously differentiable.

□ **Search and recommendations.** Each consumer j initially knows the value of her outside option x_j, but has to incur a per-search cost $s > 0$ to inspect each creator i and learn (i) whether there is a match in content type (i.e., $t_i = t_j$), and (ii) the realization of u_{ij}. Consumers search sequentially and observe nothing about each creator prior to search.[9] There are two ways for consumers to search:

- *Search directly.* This benchmark represents finding content outside of a platform, e.g. through word of mouth or getting recommendations from online social communities. This search process is *undirected* and random as in Wolinsky (1986) involving creators of all types, with each creator being uniformly and randomly drawn at every step.

- *Search through the discovery portal.* With a discovery portal, consumer search is *directed*. The platform first identifies the content type t_j the consumer j wants. Then, the platform chooses one of the creators with type $t_i = t_j$ to recommend to consumer j in every step of

[7] We think of λ as features of content that are relatively easy to change (e.g. a video game focused creator could easily switch between covering different games) whereas t reflects a more major shift (e.g. shifting from producing video game content to say, tool restoration videos, which require a completely different style of content production).

[8] As described in the introduction, this exclusive content does not have to be of the same type as the generic content. More generally, it includes other direct value transfers from viewers to creators such as membership subscriptions, voluntary donations in exchange for virtual items, and merchandise.

[9] We do not include "superstar" creators in this model as they do not face the same discovery problems that most other creators face. We discuss the role of creator asymmetry in the online appendix.

the consumer's search. After receiving each recommendation, the consumer chooses whether to follow the recommendation, which they do on the equilibrium path.

To represent the platform's recommendation, we denote $T_i = \{k : t_k = t_i\}$ as the set of creators whose types are the same as a given creator i. Then, we specify the expected number of consumers who are recommended with creator i as:[10]

$$D\left(\frac{\tilde{u}_i}{1-r}; \frac{\tilde{u}_{-i}}{1-r}\right) \geq 0. \tag{2}$$

Here,

$$\tilde{u}_i = u(\lambda_i) - \frac{s}{\lambda_i}$$

is the endogenous search reservation value of creator i in the presence of discovery portal; and $\tilde{u}_{-i}$ is the reservation value of other creators $k \neq i$, $k \in T_i$; whereas $r \in [\underline{r}, \bar{r}] \subseteq (-\infty, 1)$ is a weight indicating how sensitive the recommendations are toward reservation value differences, where r is chosen by the platform. Notice in the extreme case of $r \to -\infty$, the recommendation becomes completely random, similar to an undirected random search benchmark.

We call D the *recommendation function*, which is log-concave, strictly increasing, continuously differentiable. The strictly increasing assumption essentially means the platform is truthful and always recommends the best available option to consumers, in the sense that a consumer would make the same recommendations if it has access to the same information. Specifically, by Pandora's rule (Weitzman 1979), each consumer's optimal search sequence starts from the option with the highest $\tilde{u}_i$. Meanwhile, D being a smooth function reflects that a creator i is not necessarily recommended to all consumers of the corresponding type even if i has the highest search reservation value. In the next section, we discuss a formal discrete-choice microfoundation for function D.

□ **Creator revenue.** Creators have two sources of revenue. The first is a flat per-viewer gain which we denote by $a \geq 0$. We interpret a as external sponsorship revenues pertaining to individual creators (e.g. a fashion company directly paying an Instagram influencer to post a picture of them wearing that company's products), but it can also include creators' intrinsic and image-related utility from gaining viewers and followers (Toubia and Stephen 2013). For now, the

[10]Given that the number of types n_0 is finite, there is a continuum of consumers and creators of type t_i of equal mass. Moreover, by symmetry and closed coverage of recommendations, $D(\frac{\tilde{u}}{1-r}; \frac{\tilde{u}}{1-r}) = 1$ is constant for any symmetric $\tilde{u}$.

term a does *not* include advertising revenue accrued by the platform if it operates a discovery portal. This simplification implies that creators' participation on a discovery portal does not affect their per-viewer revenue and affects only how many consumers they gain access to. Specifically, if a creator does not join the discovery portal, they lose access to the consumers who search for content using the discovery portal (which, in the equilibrium, means all of the consumers).

The second source is the expected revenue from selling exclusive content to each viewer. More generally, this can include any other direct transactions between each viewer and a creator. We denote this expected exclusive content revenue as $v(\lambda_i)$, which is a continuously differentiable, weakly decreasing, and weakly concave function (recall a higher broadness level λ_i corresponds to a lower consumer willingness to pay for exclusive content).

The platform sets and charges a commission $\tau \in [0, 1]$ for each unit of exclusive content revenue. Therefore, for each viewer, the creator earns exclusive content revenue $(1 - \tau) v(\lambda_i)$. If a creator does not join the membership portal, its exclusive content revenue is reduced to zero, reflecting that direct transactions between viewers and creators require a membership portal.

Combining these two sources of revenue, creator i's revenue per viewer equals

$$a + (1 - \tau) v(\lambda_i) \tag{3}$$

if they join a membership portal, whereas it equals a if they do not.[11] Meanwhile, the decision of whether or not to join the discovery portal does not affect per-viewer revenue.

Finally, whenever the platform is hybrid, we assume throughout that two of its component functionalities are *unbundled*, in line with our motivating examples. This means that creators can choose to join its membership portal, its discovery portal, or both.

□ **Platform profit.** A platform operating both a discovery and a membership portal (i.e., a hybrid platform) obtains per-viewer ad revenue $A \geq 0$ via the discovery portal and transaction commission revenue $\tau v(\lambda_i)$ from each creator/consumer pair transacting through the membership portal. We interpret A as an exogenous parameter that captures the profitability of advertisement market, which is determined by a competitive ad sector. To highlight the discovery portal's role in search and recommendation, we assume for now that the platform does not share its advertisement

[11] In Section A of the Online Appendix, we illustrate how the insight of the model can be extended when $a = a(\lambda_i)$ is a function of λ_i that does not decrease too fast. Nonetheless, it is generally not obvious how $a(\lambda_i)$ should change with λ_i, and so in the main text we remain agnostic and focus fully on the consumer-induced effect of design to simplify the exposition, as in Bar-Isaac, Caruana, and Cuñat (2012).

revenue with creators.[12] If a platform chooses to operate in pure discovery or pure membership mode, then it will receive only the ad revenue or only the commission revenue respectively.

We normalize the cost of operating a membership portal to zero and denote the fixed cost of operating a discovery portal as C. The cost captures, in a reduced-form manner, the nuisance cost associated with advertisements and the cost of hosting content and maintaining a recommendation system.[13]

The following table summarizes the distinction between the three platform business models.

	Creator's per-viewer revenue	Effective search cost	Recommendation sensitivity	Platform per-viewer revenue
Pure discovery	a	s	$r \in [\underline{r}, \bar{r}]$	A
Pure membership	$a + (1-\tau)v(\lambda_i)$	$n_0 s$	no recommendation (as if $r \to -\infty$)	$\tau v(\lambda_i)$
Hybrid	$a + (1-\tau)v(\lambda_i)$	s	$r \in [\underline{r}, \bar{r}]$	$A + \tau v(\lambda_i)$

Table 2: Three modes of operation.

☐ **Timing.**

1. The platform chooses its mode of operation (pure discovery, pure membership, or hybrid).
2. The platform sets its recommendation sensitivity r (if it operates a discovery portal) and its transaction commission τ (if it operates a membership portal).
3. Creators simultaneously make participation decisions and choose design λ_i.
4. Consumers observe the platform's decisions, do *not* observe decisions by creators, and then choose whether to join the platform. Then, consumers choose whether to search through the discovery portal or search directly.

Our equilibrium concept is symmetric perfect Bayesian equilibrium (PBE) with all creators adopting the same strategy in the equilibrium.We rule out trivial equilibria in which no creators join the platform, and, expecting that, no consumers search through the platform (whenever applicable). As is standard in the search literature, we impose that consumers keep the same (passive) beliefs about unobserved creators' decisions off the equilibrium path whenever applicable.

[12]This is consistent with platforms such as Instagram which do not share ad revenue. In Section 6 we allow revenue sharing and endogenize A by allowing the platform to decide the number of ads displayed.

[13]We assume $C \leq G(\tilde{u}(\lambda^*(\bar{r}, 1)))A$ so that a monopoly pure discovery portal is always weakly profitable. In Section 6, we alternatively model the nuisance cost as a decrease in consumers' participation utility.

Discussions of modeling features

□ **Broad-niche content design.** Our broad/niche characterization should be thought of as characterizing content creators' overall positioning within a given category. For example, within the category of "gaming videos", a broad channel positioning would correspond to mass-producing easy-to-consume "top-ten" videos that compile generic information on mass-appeal games, whereas a niche channel positioning would correspond to in-depth gameplay footage of a low-profile indie game in which the creator emphasizes crafting a unique online persona within the game's community.

□ **Microfoundations for exclusive content utility and revenue.** We use functions $u(\lambda_i)$ and $v(\lambda_i)$ to capture how content design λ_i affects viewers' expected net utility from exclusive content and the corresponding expected revenue for creators. This reduced form captures several microfoundations. For example, suppose that, after a consumer becomes a viewer of creator i, with probability $1-q$ she is not interested in exclusive content at all; with the remaining probability $1-q$ she is interested with her willingness to pay (WTP) being $v_0 - \lambda_i$ (where $v_0 > 1$ is the baseline WTP with the slope parameter normalized to 1) and decides whether to pay price p_i to access it. Given this binary nature, we can — without loss of generality — set $q = 1$. If p_i is set by the creator, then Diamond's (1971) hold-up logic implies $p_i = v_0 - \lambda_i$, and so $v(\lambda_i) = v_0 - \lambda_i$ and $u(\lambda_i) = b$, where $b > 0$ is some standalone utility from becoming a viewer. More generally, if we model the price determination as a simple Nash bargaining process with relative bargaining power $\gamma \in [0,1]$, then:

$$v(\lambda_i) = (v_0 - \lambda_i)\gamma \qquad \text{and} \qquad u(\lambda_i) = b + (v_0 - \lambda_i)(1-\gamma). \tag{4}$$

□ **Interpreting the recommendation function.** Recall formulation (2) essentially assumes that the platform provides truthful recommendations conditioned on the information it has,[14] but we impose no constraints on how the platform chooses to generate the information. Therefore, one interpretation of the smooth recommendation function in (2) is the following. Suppose that there is an additional idiosyncratic utility factor ϵ_{ij} in each consumer j's utility of becoming creator i's viewer, and it is an experience-good component (i.e., its realization is observed by consumers only after becoming a viewer). At the point of making recommendations to consumer j, the platform

[14] Similar conditional truthfulness assumption has been adopted in earlier works in information design (Kamenica and Gentzkow 2011) and expert recommendations (Janssen and Williams 2023), and it may reflect that the recommender faces a high lying cost or reputational concerns for wrong recommendations (Inderst and Ottaviani 2012).

privately observes each creator i's chosen λ_i and an imperfect signal on the realization of ϵ_{ij}, and then deterministically recommends the best option to consumer j based on this information.

In this context, the factor $1-r$ in (2) captures the accuracy of the platform's signals on the idiosyncratic utility factor ϵ_{ij} (hence the relative importance of the idiosyncratic signals in its recommendations), which the platform chooses and commits to prior to the recommendation stage. In Section A of the Appendix, we construct a formal microfoundation based on the description above.[15] A useful special case of (2), which arises when ϵ_{ij} follows EVT-1 distribution, is the logit form:

$$D\left(\frac{\tilde{u}_i}{1-r};\frac{\tilde{u}_{-i}}{1-r}\right)=\frac{\exp\left(\frac{\tilde{u}_i}{1-r}\right)}{\int_{k\in T_i}\exp\left(\frac{\tilde{u}_k}{1-r}\right)}. \tag{5}$$

4 Analysis of monopoly benchmark

Creators and consumers decisions

We start by characterizing the equilibria in the creator-consumer subgame under each of the three business modes of the platform: pure membership mode, pure discovery mode, or hybrid mode. We will consider the case of hybrid mode, and then demonstrate how the analysis can be adapted to the other two modes.

Lemma 1. *(Hybrid mode subgame). For each given (r,τ), the equilibrium of the consumer-creator subgame is:*

1. *Each creator i joins both portals of the platform and sets equilibrium design*

$$\lambda^*=\arg\max_{\lambda_i\in[0,1]}\left\{D\left(\frac{\tilde{u}(\lambda_i)}{1-r};\frac{\tilde{u}(\lambda^*)}{1-r}\right)(a+(1-\tau)v(\lambda_i))\lambda_i\right\}, \tag{6}$$

where the search reservation value is

$$\tilde{u}(\lambda_i)\equiv u(\lambda_i)-\frac{s}{\lambda_i}. \tag{7}$$

2. *Each consumer believes that all creators adopt strategy λ^* in (6), and initiates search if and only if their outside option is $x\leq\tilde{u}(\lambda^*)$, and does so through the discovery portal (following*

[15] Intuitively, we can interpret weight r as indexing machine learning algorithms in terms of what type of consumer interaction information they emphasize when generating predictions on consumer utility. A high-r algorithm assigns relatively more weight to the more "superficial" interaction information such as propensity to click on/watch content, relative to the more "intensive" interaction information such as watch time and commenting.

the platform's recommendation at every step of the search process). The mass of consumers who search is $G\left(\tilde{u}(\lambda^*)\right)$.

3. *Upon observing a positive match value with a creator, the consumer stops searching and becomes a viewer of the creator.*

To sketch the equilibrium construction, we first note that, upon receiving the recommendation, a consumer has no incentive to deviate because the recommendation is consistent with the optimal search sequence (Pandora's rule), on and off the equilibrium path. Then, consumers' search decision follows the standard threshold rule from Weitzman (1979) and Wolinsky (1986): stops searching and becomes a viewer of creator i if there is a match and the observed utility $u\left(\lambda_i\right)$ is higher than the equilibrium continuation value $\tilde{u}(\lambda^*)$, and continues searching otherwise. On the equilibrium path, the stationary search environment implies $\tilde{u}(\lambda^*)$ satisfies the recursive relation

$$\begin{aligned} & \tilde{u}(\lambda^*) = \lambda^* u\left(\lambda^*\right) + \left(1-\lambda^*\right)\tilde{u}(\lambda^*) - s \\ \Rightarrow \quad & \tilde{u}(\lambda^*) = u(\lambda^*) - \frac{s}{\lambda^*}. \end{aligned}$$

Clearly, the stopping utility with a matched creator $u(\lambda^*)$ is strictly greater than $\tilde{u}(\lambda^*)$, meaning that consumers stop searching upon finding a match, as described in Lemma 1.[16]

Consider a creator i's decisions on the equilibrium path. This is analogous to the limit case of Wolinsky (1986) and Bar-Isaac, Caruana, and Cuñat (2012) and our argument follows theirs. Denote ρ as the fraction of consumers who are recommended to other creators $k \in T_i, k \neq i$ that result in a positive match and successful viewer conversion; this is exogenous from creator i's perspective given that each creator is atomistic. For every consumer who initiates search, denote the fraction of consumers who are recommended i and become a viewer of i in the first round of search as m_i. Provided that any consumer who has a positive match with creator i stops searching, we can write $m_i = D \times \lambda_i$. In the second round of search, a further $(1-\rho)m_i$ consumers do not find a match in the first round of search are recommended i and become i's viewers; In the third round, a further $(1-\rho)^2 m_i$ consumers become i's viewers; and so on, which sum up to m_i/ρ.

[16] This stopping rule is a consequence of the binary search outcome from the utility expression (1). In Section A of the Online Appendix, we modify utility expression (1) to include idiosyncratic draws in search outcome à la Wolinsky (1986), in which case consumers will stop searching only if the realized draw is above a threshold. The resulting equilibrium characterization generalizes Lemma 1 but still exhibits the same key features.

Dropping the multiplicative factor $1/\rho$ that is exogenous, creator i's profit is proportional to

$$D \times \lambda_i \times (a + (1-\tau)v(\lambda_i)),$$

which gives the optimal content design in (6). Whenever $\lambda^* > 0$ is interior, then the corresponding first-order condition (FOC) is

$$\underbrace{\left(\frac{a}{1-\tau} + v(\lambda^*)\right)\left(\frac{1}{\lambda^*} + \frac{1}{1-r}\frac{D'}{D}\frac{\partial \tilde{u}}{\partial \lambda}\right)}_{\text{marginal revenue from expanded audience}} + \underbrace{v'(\lambda^*)}_{\substack{\text{marginal loss in} \\ \text{transaction revenue}}} = 0, \tag{8}$$

where D' is the first derivative of $D(\cdot;\cdot)$ with respect to its first argument. The FOC reflects the standard trade-off between marginal revenue from expanding viewership (by raising $D \times \lambda_i$) and the inframarginal loss from a lower per-viewer exclusive content revenue (given $v' < 0$).

We will sometimes express (6) as $\lambda^*(r, \tau)$, i.e., a function of r and τ chosen by the platform. Extending Lemma 1, the equilibrium in the subgame for the other two modes are:

- (*Pure membership mode subgame*). Without a discovery portal, consumers search randomly as in Wolinsky (1986). Hence, for given τ, the equilibrium design is $\lim_{r \to -\infty} \lambda^*(r, \tau)$, which we will express as $\lambda^*(-\infty, \tau)$ with a slight abuse of notation. The search reservation value is

  $$\tilde{u}_0(\lambda_i) \equiv u(\lambda_i) - \frac{n_0 s}{\lambda_i}, \tag{9}$$

  reflecting the higher effective search cost ($n_0 s \geq s$) in this environment.

- (*Pure discovery mode subgame*). Without a membership portal, creators earn no exclusive content revenue, as if $\tau = 1$. Consumer search behaviour remains the same as Lemma 1. Hence, the equilibrium design is $\lambda^*(r, 1)$ and the search reservation value remains $\tilde{u}(.)$, as defined in (7).

The following proposition formalizes how the platform's choices of r and τ affect the design decisions $\lambda^*(r, \tau)$ in the subgame. Note that introducing a discovery portal is equivalent to the special case of raising recommendation sensitivity from $r = -\infty$ to $r > -\infty$; whereas introducing a membership portal is equivalent to reducing the commission rate from $\tau = 1$ to $\tau < 1$.

Proposition 1. *For each given (r, τ), consider the equilibrium in Lemma 1.*

- *Discovery portal: there exists a unique threshold* $\bar{s}$ *such that* $\lambda^*(r,\tau)$ *is weakly increasing (decreasing) in* r *if* $s \geq (\leq)\bar{s}$*. Meanwhile, consumer search reservation value* $\tilde{u}(\lambda^*(r,\tau))$ *is always weakly increasing in* r*.*

- *Membership portal:* $\lambda^*(r,\tau)$ *is weakly decreasing in* τ*.*

The first part of Proposition 1 says that the implications of adding the discovery portal depends on the search environment. Intuitively, adding a discovery portal (or more generally, a higher sensitivity r) induces a "chase-the-algorithm" effect that incentivizes creators to choose a design that raises their search reservation value $\tilde{u}(\lambda_i) \equiv u(\lambda_i) - \frac{s}{\lambda_i}$. The latter is a function of an intensive margin (conditional utility $u(\lambda_i)$) and an extensive margin (match likelihood λ_i, weighted by the search cost). When the search cost is high, the extensive margin dominates so that $\tilde{u}(\lambda_i)$ is increasing in λ_i, and creators chase the algorithm by increasing broadness. Conversely, when the search cost is low, creators chase the algorithm by decreasing broadness.

The second part of Proposition 1 says that adding the membership portal (or more generally, a lower commission τ) always induces creators to decrease broadness. Creators now assign a greater weight on their exclusive content revenue in their maximization problem, which calls for more niche content.

Platform decisions and comparing platform business models

Building upon the subgame analysis in the previous subsection, we now analyze the platform's decisions. In what follows, we denote variables associated with platforms operating in pure membership, pure discovery, or hybrid mode by M, D and H respectively.

In the pure membership mode,

$$\Pi_M^* = \max_{\tau \in [0,1]} G\left(\tilde{u}(\lambda^*(-\infty,\tau))\right) \times \tau v(\lambda^*(-\infty,\tau)),$$

If creators' design were exogenous, then the platform optimally sets the highest possible τ. However, the endogeneity of design generates a trade-off: a higher τ induces creators to shift towards broader designs, which expands the total number of viewers but reduces the platform's exclusive content commission. In the pure discovery mode,

$$\Pi_D^* = \max_{r \in [\underline{r},\bar{r}]} G\left(\tilde{u}(\lambda^*(r,1))\right) \times A - C.$$

Clearly, the platform optimally chooses $r = \arg\max \tilde{u}\left(\lambda^*(r,1)\right) = \bar{r}$ to maximize the total number of viewers. Finally, in the hybrid mode,

$$\Pi_H^* = \max_{(r,\tau)\in[\underline{r},\bar{r}]\times[0,1]} G\left(\tilde{u}(\lambda^*(r,\tau))\right) \times \left(A + \tau v(\lambda^*(r,\tau))\right) - C.$$

The platform faces a trade-off between balancing its two sources of revenue. Maximizing its advertising income requires it to maximize viewership, whereas maximizing its transaction revenue (from exclusive content sales) requires it to induce niche content design.[17] Accordingly, we denote the profit-maximizing choices in each mode as τ_M^*, r_D^*, and (r_H^*, τ_H^*), with the concomitant equilibrium designs denoted by λ_M^*, λ_D^*, and λ_H^*.

We first start from the pure membership mode and identify how introducing a discovery portal affects platform's profit and market outcomes in the equilibrium. Consistent with Proposition 1, we find that the implications depend on the search environment. To proceed, define thresholds on search cost that ensure monotonicity of search reservation value $\tilde{u}(\lambda_i)$:

$$s \;>\; \bar{s}_{\max} \equiv -\lambda_{\max}^2 u'(\lambda_{\max}) \Rightarrow \frac{\partial \tilde{u}}{\partial \lambda_i} < 0 \text{ for all } \lambda_i \in [\lambda_{\min}, \lambda_{\max}] \tag{10}$$

$$s \;<\; \bar{s}_{\min} \equiv -\frac{\lambda_{\min}^2}{n_0} u'(\lambda_{\min}) \Rightarrow \frac{\partial \tilde{u}}{\partial \lambda_i} < 0 \text{ for all } \lambda_i \in [\lambda_{\min}, \lambda_{\max}], \tag{11}$$

where $\lambda_{\max} \equiv \max_{r\in[\underline{r},\bar{r}]} \lambda^*(r,1) \leq 1$ and $\lambda_{\min} \equiv \min_{r\in[\underline{r},\bar{r}]} \lambda^*(r,0) > 0$ are the maximum and minimum that can feasibly arise in the model for given parameters. Then:

Proposition 2. *Consider a move from the pure membership mode to hybrid mode. There exist weakly positive thresholds A_{mono}, A'_{mono}, and B'_{mono} such that the following hold.*

- *If $s > \bar{s}_{\max}$, then the equilibrium content design becomes broader ($\lambda_H^* \geq \lambda_M^*$) if $A \geq A'_{mono}$; and platform profit increases if and only if $A \geq A_{mono}$. Moreover, $A_{mono} > 0$ if τ_M^* is interior and G is sufficiently inelastic.*

- *If $s < \bar{s}_{\min}$, then the equilibrium content design becomes less broad ($\lambda_H^* \leq \lambda_M^*$) if $A \geq B'_{mono}$; and platform profit always increases.*

Furthermore, $A'_{mono} = 0$ and $B'_{mono} = 0$ if $n_0 = 1$.

[17] Notice that for any strictly interior (r,τ), the platform can strictly increase its profit by increasing τ while adjusting r downward to maintain the same design λ^*. Hence, we must have either $\tau = 1$ or $r = \underline{r}$ (or both) for the hybrid platform's optimal solution.

The content design implications of Proposition 2 are intuitive because introducing the discovery portal (i) creates competition for recommendations, which induces creators to change their design in a way that raises $\tilde{u}(\lambda_i)$; and (ii) generates advertising revenue $A \geq 0$, which incentivizes the platform to increase viewership size by changing its commission τ in a way that induces creators to raise $\tilde{u}(\lambda_i)$. The latter can be seen from the associated FOC of τ_H^*:

$$\frac{G\left(\tilde{u}\left(\lambda^*\right)\right)}{g\left(\tilde{u}\left(\lambda^*\right)\right)}\left(v(\lambda^*) + v'(\lambda^*)\tau\frac{\partial\lambda^*}{\partial\tau}\right) + \left(A + \tau v(\lambda^*)\right)\underbrace{\frac{\partial\tilde{u}}{\partial\lambda_i}\frac{\partial\lambda^*}{\partial\tau}}_{\geq 0} = 0.$$

Both effects call for a broader equilibrium design when $s > \bar{s}_{\max}$ (and a less broad equilibrium design when $s < \bar{s}_{\min}$). The only potential counteracting effect is the decrease in effective search cost after adding the discovery portal i.e., $s < n_0 s$, which generally has an ambiguous effect on platform's choice of commission τ. Proposition 2 essentially shows that this counteracting effect is dominated when A is large relative to search cost difference.[18]

The profit result in Proposition 2 says that the hybrid mode can be less profitable than the pure membership mode. This possibility is driven by the change in design of creators in response to recommendations. To see this formally, suppose $A = C = 0$ and platform viewership size is a constant at $G > 0$, so that the only difference between the two modes is the platform recommendations. Then $\Pi_H^* < \Pi_M^*$ if and only if

$$\max_{(r,\tau)\in[\underline{r},\bar{r}]\times[0,1]} \tau v(\lambda^*(r,\tau)) < \max_{\tau\in[0,1]} \tau v(\lambda^*(-\infty,\tau)). \tag{12}$$

Given that $v(.)$ is decreasing, the Envelope Theorem implies that (12) holds if and only if platform recommendations result in a broader design (e.g., when $s > \bar{s}_{\max}$). Meanwhile, if recommendations result in a less broad design (e.g., when $s < \bar{s}_{\min}$), then (12) never holds and the switch to hybrid unambiguously increases platform profit. Figure 2 below illustrates this trade-off more generally. Consistent with the intuition above, we find that a high profitability A, a low search cost s, and a weak chase-the-algorithm effect tend to favor the hybrid mode, and vice-versa.

In sum, adding a discovery portal leads to a "chase-the-algorithm" effect which promotes creators with a higher search reservation value, which boosts platform viewership. In environments where consumers' effective search cost is relatively high, such an algorithm would favor broadness and induce broader design, which reduces the platform's commission revenue from exclusive

[18] In our numerical exercises, we find that $A'_{mono} = 0$ in most cases, including cases where n_0 is large, except when $\underline{r}$ is not extremely negative.

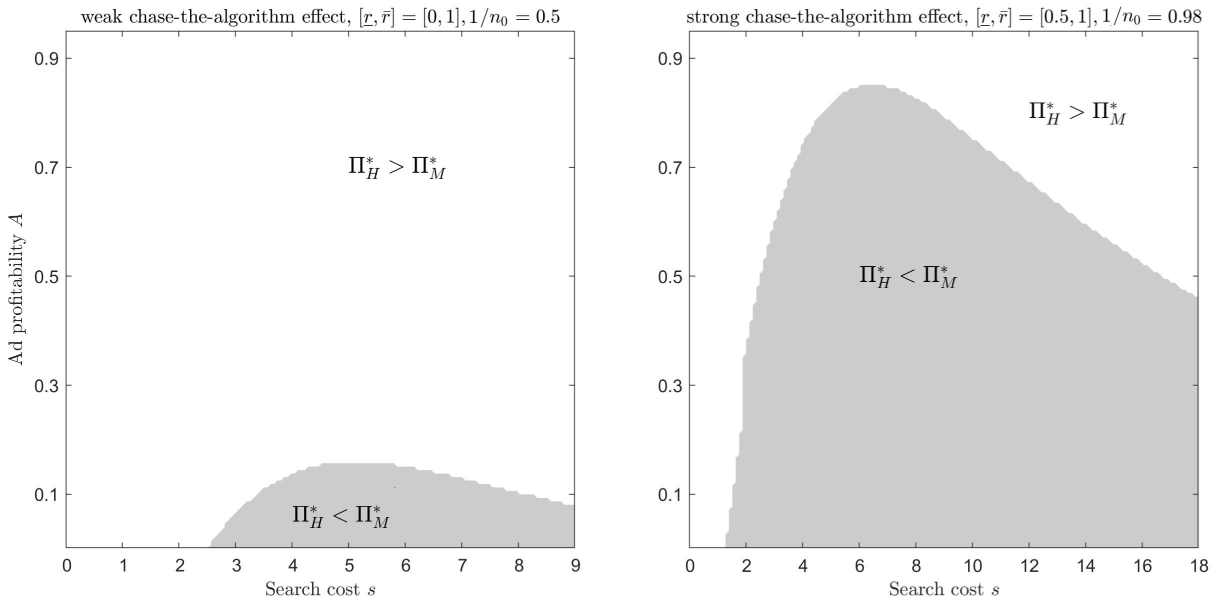

Figure 2: Profit comparisons. We set $G \sim$Normal(-5,5), $v(\lambda_i) = u(\lambda_i) = 3(1 - \lambda_i^2)$, $a = 0.5$, $C = 0$. These parameters imply $\bar{s}_{\max} \approx 6$ and $\bar{s}_{\min} \approx 1$.

content. In this case, adding the discovery portal involves a trade-off between the viewership size and per-viewer revenue. In contrast, in environments where consumers' effective search cost is low, such an algorithm would favor nicheness and induce less broad design, which increases the platform's commission revenue and the trade-off disappears.

Next, we consider the pure discovery mode and look the equilibrium implications of introducing a membership portal.

Proposition 3. *Consider a move from pure discovery mode to hybrid mode. The equilibrium content design becomes less broad ($\lambda_H^* \leq \lambda_D^*$); and the platform profit increases ($\Pi_H^* > \Pi_D^*$).*

Proposition 3 says that adding the membership portal induces a shift towards niche content design in the equilibrium. This extends the intuition in Proposition 1 to the overall equilibrium. Intuitively, in the pure discovery mode the platform sets sensitivity weight at $\bar{r}$ to maximize $\tilde{u}(\lambda^*)$; whereas in the hybrid platform the platform has an additional incentive of choosing r in a way that decreases the design broadness to raise its revenue from taxing exclusive content. Here, one might worry that the shift towards niche designs may be undesirable for the platform if viewership expansion is important (e.g., if G is highly elastic). Proposition 3 says that the hybrid platform can exactly replicate the equilibrium design of the pure discovery mode by setting $r = r_D^*$ and commission $\tau = 1$. Then, a profit replication argument implies $\Pi_H^* > \Pi_D^*$. However, this argument relies on the platform not facing any competitive constraints in its commission, which no longer holds in the next section.

We summarize the monopoly platform's optimal business model as follows.

Corollary 1. *(Monopoly equilibrium). The monopoly optimally chooses hybrid mode if the ad profitability A is sufficiently high, and chooses pure membership mode otherwise.*

Corollary 1 offers a few managerial implications. First, adding a membership portal always increases profit so that pure discovery platform is never optimal for the monopoly platform. This result is consistent with the observation that several platforms in Table 1 that started in pure discovery mode have switched to hybrid mode (e.g., Youtube, Facebook, and Twitter). Second, adding a discovery portal does not always increase profit due to the trade off arising from the chase-the-algorithm effect. The trade off helps to explain why some well-established pure membership platforms like Patreon and Teachable do not offer more extensive discovery services. If they were to do so, creators would adjust their content design to appeal to the recommendation algorithm. This would potentially reduce value for the exclusive content given to users of the platform, especially if the effective search cost remains high after introducing the discovery feature.[19]

5 Competing platforms

In this section, we explore how the insights from the monopoly case in Section 4 change when there are multiple platforms. We start by analyzing a benchmark competition model in Section 5 where both consumers and creators are free to multihome on all platforms. Then, we show in Section 5 how the insights change under other homing assumptions.

Throughout this section we will focus on the case where the search cost $s \geq \bar{s}_{\max}$, as defined in (10). This is a more interesting than a low search cost environment as the platform faces a real tradeoff in the form of reduced commission revenue from content creators chasing the algorithm. In this case, both $\tilde{u}(\lambda_i)$ and $\tilde{u}_0(\lambda_i)$ defined in Section 4 are monotone increasing, and so the platform's recommendations favor creators with higher λ_i.

Benchmark: complete multihoming

Suppose there are two platforms $l = 1, 2$ that are ex-ante homogeneous (in the sense that there is no horizontal differentiation). Each platform decides its modes of operation. Consumers

[19]See Jenkins (2019) for some discussion of this tradeoff by Patreon itself. Likewise, Teachable's homepage https://teachable.com/ advertises "escape the algorithm" as part of its appeal to creators.

and creators are free to multihome: they can freely join multiple discovery portals and multiple membership portals, as in Rochet and Tirole (2003). Following the tie-breaking rule in Section 3, we assume that creators and consumers join each given portal (membership or discovery) whenever they are indifferent between joining and not joining. There are a few additional specifications on consumers' and creators' behaviors when they multihome.

First, a consumer who multihomes on two discovery portals can freely choose to use either of the two portals (or search directly) in every step of search.[20] If the consumer becomes a viewer of a creator that matches her taste, it creates platform advertising revenue only on the discovery portal where the match occurs.

Second, consider a consumer who multihomes on two membership portals and wants to purchase exclusive content from a creator. We assume she can choose which membership portal to complete the transaction on (that she and the creator have joined in common). Whenever multiple membership portals are available for transactions, we assume consumers randomly select one of the available portals with equal probability, which is without loss of generality given that membership portals are homogeneous in our model.

Third, consistent with the benchmark model, each creator i makes a single content design decision λ_i that is not contingent on how each consumer finds the creator. In other words, creators do not tailor their content design λ_i to each platform.[21]

The timing of this model is the same as the monopoly benchmark, except that the platforms simultaneously choose their modes of operation in Stage 1, and then simultaneously choose weight r_l and/or commission τ_l in Stage 2. We start by describing the creator-consumer subgame for given $(\tau_l, r_l)_{l=1,2}$, where $r_l = -\infty$ if Platform l does not operate a discovery portal, and $\tau_l = 1$ if Platform l does not operate a membership portal. Then, the construction of the equilibrium is similar to Lemma 1:

Lemma 2. *Let* $r_{\max} = \max\{r_1, r_2\}$ *and* $\tau_{\min} = \min\{\tau_1, \tau_2\}$*. The equilibrium of the consumer-creator subgame is:*[22]

1. *Each creator i joins all discovery portal(s) but joins only the membership portal with the*

[20] Nonetheless, on the equilibrium path this possibility is never utilized: once a consumer has chosen a discovery portal to start searching, she has no incentive to switch to another portal (even though they are multihoming on both discovery portals).

[21] This modeling feature is consistent with our motivating examples of online video creation, where creators often upload the same set of videos and streaming footage on multiple platforms such as Youtube and Twitch. Recall λ_i is interpreted as the overall channel positioning strategy of a creator.

[22] The characterization in this lemma implicitly assumes that at least one discovery portal exists. If no discovery portal exists, the same characterization still applies after replacing $\tilde{u}(.)$ with $\tilde{u}_0(.)$ in (9).

lowest τ_l (or both if $\tau_1 = \tau_2$). Then, the creator sets design

$$\lambda^* = \arg\max_{\lambda_i \in [0,1]} \left\{ D\left(\frac{\tilde{u}(\lambda_i)}{1 - r_{\max}}; \frac{\tilde{u}(\lambda^*)}{1 - r_{\max}} \right) (a + (1 - \tau_{\min}) v(\lambda_i)) \lambda_i \right\}$$

where the search reservation value is given by $\tilde{u}(\lambda_i)$ in (7).

2. *Each consumer joins all discovery portal(s) and all membership portal(s). Believing that all creators adopt strategy λ^*, a consumer initiates search if and only if their outside option $x \leq \tilde{u}(\lambda^*)$ and does so through the discovery portal with the highest r_l (and follows the recommendation for every search). The mass of consumers who search is $G(\tilde{u}(\lambda^*))$.*

3. *Upon observing a positive match value with a creator, the consumer stops searching and becomes a viewer of the creator. The consumer uses one of the membership portals that the matched creator has joined to carry out transactions (if any).*

A few comments are in order on the equilibrium construction in Lemma 2. First, all creators singlehome on the membership portal with the lowest τ_l. Doing so allows a creator to force consumers who want to transact with it to use the portal with the lower commission (given that consumers are multihoming). In the case of $\tau_1 = \tau_2$, creators are indifferent between the two membership portals and so they multihome.

Second, it is a weakly dominant strategy for any given consumer to join all portals of both platforms due to the assumptions of (i) zero multihoming cost and (ii) consumers get to choose the medium of transactions.

Third, given that all creators are multihoming and choosing the same λ_i, on the equilibrium path consumers are indifferent to the choice of discovery portal for search even if $r_1 \neq r_2$. The construction in Lemma 2 involves selecting the equilibrium that would have arise if there is a small but vanishing extent of asymmetry in the equilibrium λ_i by creators. Intuitively, the Pandora's rule underlying recommendation function (2) implies that consumers expect greater utility from searching through the portal with the higher r_l.

Moving to the platforms' decisions, we use $P_l \in \{M, D, H\}$ to denote Platform l as operating in pure membership, pure discovery, and hybrid modes respectively. The following proposition describes Platform l's best-responding business mode as a function of the opponent's choice P_{-l}.

Proposition 4. *(Best-responding business mode in complete multihoming). There exist thresholds $A_{MH} \geq A'_{MH} \geq 0$ such that:*

- *If $P_{-l} = M$, Platform l optimally chooses D;*
- *If $P_{-l} = H$, Platform l optimally chooses D if $A \geq A'_{MH}$ and chooses M if $A \leq A'_{MH}$;*
- *If $P_{-l} = D$, Platform l optimally chooses H if $A \geq A_{MH}$ and chooses M if $A \leq A_{MH}$.*

Moreover, both thresholds increase with C and equal zero when $C = 0$.

The first two parts of Proposition 4 imply that when the opponent platform is operating a membership portal component (that is, $P_{-l} \in \{M, H\}$), it is unprofitable for platform l to switch from pure discovery to hybrid. Formally, if we denote $\Pi_l^*(P_l, P_{-l})$ as platform l's profit given the mode profile (P_l, P_{-l}) by both platforms, then:

$$\Pi_l^*(H, P_{-l}) < \Pi_l^*(D, P_{-l}) \qquad \text{for} \quad P_{-l} \in \{M, H\}\,. \tag{13}$$

That is, strategic considerations overturn the monopoly result in Proposition 3. Intuitively, the intense competition between two homogeneous membership portal components drives down platforms' commissions on exclusive content to $\tau = 0$ following standard Bertrand logic. This raises creators' revenue from exclusive content. In response, creators shift towards niche content designs, resulting in fewer visiting consumers and hence a negative "spillover" on Platform l's existing total revenue from advertisement.

This negative spillover mechanism describes a consequence of the competition that industry observers have been describing as "an arms race to acquire creators" (Culliford and Dang 2021): when a platform introduces a membership portal that competes with its rival, not only does it reduce the industry profit from transaction commissions, but it also generates a negative spillover effect on the platform's existing advertising revenue due to the shift in creator production towards niche content design.

The third part of Proposition 4 follows from the logic of Proposition 3: $P_l = D$ is never a best response when $P_{-l} = D$. Then, in choosing between M and H, Platform l faces a trade-off between the fixed cost C of introducing a discovery portal and the new revenue source from advertisement $A/2$ (revenue is halved because viewership is split evenly between the two discovery portals). The key difference with the monopoly case is that the potential downside of the hybrid mode — the "chase-the-algorithm effect" — is absent because $P_{-l} = D$ means that creators always face a recommendation system, no matter Platform l's choice of business model.

From the best responses in Proposition 4, we immediately obtain the following overall equilibrium (if $A = A_{MH}$, then both types of equilibria below coexist).

Proposition 5. *(Complete multihoming equilibrium) In the equilibrium of the overall game:*

- *If $A \geq A_{MH}$, one platform operates in hybrid mode and the other platform operates in pure discovery mode.*
- *If $A \leq A_{MH}$, one platform operates in pure membership mode and the other platform operates in pure discovery mode.*

Intuitively, when two discovery portals coexist, platforms compete for consumer viewership, driving down their advertisement revenue. Proposition 5 says that if the ad market is sufficiently profitable (large A), it can sustain the coexistence of discovery portals by both platforms, with only one of them additionally operating a membership portal due to the negative spillover logic of (13), so that $P_l = H$ and $P_{-l} = D$. If the ad market is not highly profitable, two discovery portals cannot coexist in the market. In this case, platforms avoid direct competition for consumer viewership by operating distinct portals, so that $P_l = M$ and $P_{-l} = D$.[23]

Based on Proposition 5, the following corollary compares the duopoly equilibrium with the monopoly benchmark in terms of the equilibrium content design.

Corollary 2. *Comparing the equilibrium in Proposition 5 with the monopoly benchmark:*

- *If $A \leq A_{mono}$, then platform competition induces a weakly higher λ^*.*
- *If $A > A_{mono}$, then platform competition induces a weakly higher λ^* if $\bar{r} \to \infty$ and a weakly lower λ^* if $\bar{r} \to \underline{r}$.*

Intuitively, in the equilibrium with multiple platforms, at least one platform operates in pure discovery. This implies a recommendation system with maximal sensitivity $r = \bar{r}$, which induces broader design (all else being equal) than the monopoly case. Nonetheless, this recommendation effect has to be weighted against any potential changes in the equilibrium commission τ. Corollary 2 essentially says that the recommendation effect dominates any effect arising from changes in τ as long as A is small or $\bar{r}$ is large, and is dominated otherwise.

[23] In Section B.1 of the Online Appendix, we additionally analyze a model of platforms making sequential choices of business model (with Platform 1 being the first mover), and examine strategic preemption incentives in the first-mover's choice of business model. We find that the first mover monopolizes the membership portal market by operating a membership portal preemptively if ad profitability A is either very large ($P_1 = H$) or very small ($P_1 = M$). For some parameter configurations, there exists an intermediate region of A such that the first mover operates the sole discovery portal ($P_1 = D$).

Competitive bottlenecks with singlehoming consumers

In the equilibrium characterized by Proposition 5, there is no coexistence of two membership portals because the homogeneous platforms compete intensely in commission to attract creators. This suggests that weakening the extent of commission competition is a necessary ingredient for other equilibrium configurations of business models. Following the two-sided market literature, one simple method is to introduce the "competitive bottleneck" (CB) setup of Armstrong (2006) and Armstrong and Wright (2007), that is, consumers can join at most one membership portal (singlehoming) whereas creators are free to multihome. This may reflect that consumers face multihoming costs for signing up and maintaining their payment details across multiple membership platforms.

Note that it *does not* matter whether consumers are allowed to join multiple discovery portals: in the equilibrium of any possible consumer-creator subgame, Lemma 2 says that consumers only use one of the portals to carry out all the searches. Hence, without loss of generality we assume consumers are free to multihome on both discovery portals. This allows for an easier comparison with the complete multihoming benchmark of Section 5.

In the symmetric equilibrium of this competitive bottleneck setup, whenever multiple membership portals coexist, consumers are indifferent between the portals and split themselves across the two portals equally. Meanwhile, creators always join both membership portals (including off-equilibrium paths) instead of singlehoming on the portal with the lowest commission τ_l. This reflects the classic competitive bottleneck logic where each membership portal exerts monopoly power over the creators: if a creator quits a membership portal, it loses the opportunity to transact with all consumers who singlehome on this portal.[24]

Thus, the equilibrium design in the consumer-creator subgame is now:

$$\lambda^* = \arg\max_{\lambda_i \in [0,1]} \left\{ D\left(\frac{\tilde{u}(\lambda_i)}{1-r_{\max}}; \frac{\tilde{u}(\lambda^*)}{1-r_{\max}}\right)(a + (1-\tau_{mean})v(\lambda_i))\lambda_i \right\}$$

where $r_{\max} = \max\{r_1, r_2\}$ and $\tau_{mean} = \frac{\tau_1}{2} + \frac{\tau_2}{2}$ (if there are two coexisting membership portals) or $\tau_{mean} = \tau_l$ (if platform l operates the sole membership portal). Meanwhile, all other equilibrium features in Lemma 2 remain unchanged. Then, the following is analogous to Proposition 4:

Proposition 6. *(Best-responding business mode in a CB setting). For every $P_{-l} \in \{M, D, H\}$, there exists a threshold $A_{CB}^{(P_{-l})}$ such that Platform l optimally chooses H if $A \geq A_{CB}^{(P_{-l})}$ and chooses*

[24] This line of argument is not specific to our setting. See, e.g., Teh and Wright (2024) on how this logic extends to more general environments.

M if $A \le A_{CB}^{(P_{-l})}$.

Notably, pure discovery mode is never optimal in this competitive bottleneck setting, similar to the monopoly benchmark. The key intuition is that the coexistence of membership portals no longer drives down equilibrium commissions, which is a consequence of the competitive bottleneck logic. Thus, the negative spillover effect discussed in Section 5 is shut down, so that the hybrid mode always dominates the pure discovery mode. In this case, the trade-off between $P_l = M$ and $P_l = H$ then reflects the same intuition in the monopoly benchmark (Proposition 2).

From the best response functions in Proposition 6, we obtain the overall equilibrium:

Proposition 7. *(Competitive bottleneck equilibrium) In the equilibrium of the overall game:*[25]

- *If* $A \ge A_{CB}^{(H)}$*, then both platforms operate in hybrid mode.*
- *If* $A \in (A_{CB}^{(M)}, A_{CB}^{(H)})$*, one platform operates in pure membership mode and the other platform operates in hybrid mode.*
- *If* $A \le A_{CB}^{(M)}$*, then both platforms operate in pure membership mode.*

To sum, in the competitive bottleneck setup, commission competition between membership portals is weak, which gives rise to coexistence of platforms in pure membership and hybrid modes. Another way to generate similar equilibrium market structures is to stick with the complete multihoming benchmark but introduce strong horizontal differentiation among membership portals (thus softening competition between them). This alternative setup can be interpreted as describing a market that is "mature" on the creator side. Platforms have loyal creators that are familiar with their interfaces and payment functionalities such that the creators do not switch to the rival membership portal except when there is only one membership portal in the market.[26]

6 Additional Analysis

In what follows, we present the main insights from two extended analyses of our benchmark monopoly model: (i) surplus and welfare implications of platform business models, and (ii) allowing the discovery portal to endogenously set the amount of ads and participation fees for consumers.

[25]Note that it is possible that $A_{CB}^{(M)} \ge A_{CB}^{(H)}$, in which case we have coexistence of two types of equilibria: $(P_l, P_{-l}) = (H, H)$ and (M, M).

[26]We consider such a setup in Section B.2 of the Online Appendix where the membership portals are local monopolies from the point of view of creators. Assuming G is sufficiently inelastic, we find results similar to Proposition 7.

We relegate details and formal proofs to Sections C and D of the Online Appendix.[27] Throughout this section we will focus on the relatively more interesting case where the search cost $s \geq \bar{s}_{\max}$, as defined in (10), where the trade-offs across platform's business models arise.

Surplus and welfare implications

Our first welfare analysis compares user (consumers and creators) surplus and total surplus in the equilibrium under each business model D, M, and H presented in Section 4. The goal is to examine potential misalignment in business model adoption in the equilibrium in which the profit-maximizing platform chooses the business model that does not maximize total surplus.

Consider user surplus in the hybrid mode. Recall from the definition of search reservation value $\tilde{u}(\lambda_i)$ in (7) that it is a consumer's expected utility from engaging in search. Therefore, for given r and τ chosen by the platform and the equilibrium design $\lambda^*(r,\tau)$, the aggregate consumer surplus and creator surplus (i.e., producer surplus) are

$$\begin{aligned} CS &\equiv \tilde{u}(\lambda^*)G(\tilde{u}(\lambda^*)) + \int_{\tilde{u}(\lambda^*)}^{\infty} xg(x)dx \\ PS &= G(\tilde{u}(\lambda^*))(a + (1-\tau)v(\lambda^*)). \end{aligned}$$

The same expressions apply to the pure discovery mode (by setting $\tau = 1$) and the pure membership mode (by replacing $\tilde{u}(\lambda^*)$ with $\tilde{u}_0(\lambda^*)$). Comparing CS and PS across the three modes, we get:

Corollary 3. *Consider the benchmark monopoly model and suppose* $s > \bar{s}_{\max}$.

- $CS_M \leq CS_H \leq CS_D$ *if* $A \geq A'_{mono}$*, where* A'_{mono} *is defined in Proposition 2.*
- $PS_M \leq PS_D \leq PS_H$ *if* $\max_{\lambda_i} |\frac{v'(\lambda_i)}{v(\lambda_i)}|$ *is not too large and* n_0 *is large.*

Observe that CS is increasing in $\tilde{u}(\lambda)$, which is an increasing function by $s \geq \bar{s}_{\max}$. Therefore, $CS_M \leq CS_H \leq CS_D$ follows from $\lambda^*_M \leq \lambda^*_H \leq \lambda^*_D$ when $A \geq A'_{mono}$ holds. This ranking primarily reflects the platforms' incentives in attracting consumer participation under each mode. A pure discovery platform's sole motivation is to maximize participation, which means maximizing consumer surplus. Likewise, a hybrid platform has more incentive to attract consumers than a

[27] In earlier versions of the article, we also considered two other extensions: (iii) allowing creators to be heterogeneous and choose asymmetric content design in the equilibrium; and (iv) allowing for cross-group network effects in creator and consumer participation decisions. The extensions show that the main insights from the benchmark monopoly model remains valid in richer environments. Details are available in Sections E and F in the Online Appendix.

pure membership platform when it receives large ad revenue. Finally, the consumers' effective search cost is the highest in the pure membership mode due to the absence of the discovery portal.

The implications for creator surplus are less clear-cut. Recall that in the equilibrium, $\lambda_H^* \leq \lambda_D^*$, and so participation is weakly reduced with the addition of a membership portal. However, the membership portal also opens up additional monetization for content creators. If $\max_{\lambda_i} |\frac{v'(\lambda_i)}{v(\lambda_i)}|$ is not too large then the additional monetization does not impact design decisions too much, meaning the second effect dominates and $PS_D < PS_H$. Similarly, a pure membership platform allows for transaction revenue but a pure discovery platform increases consumer participation. If n_0 is relatively large (i.e., search is inefficient without discovery portals) then the latter dominates and so $PS_M < PS_D$.

Define total surplus as $W = CS + PS + \Pi$. The comparison is more complex in this case because Corollary 3 means that consumer and creator surplus can move in opposite directions with a business model shift. Let $I_{\{not\ M\}}$ (likewise, $I_{\{not\ D\}}$) be an indicator function that equals one if the platform is not operating in pure membership (pure discovery) mode, and equal to zero otherwise. Then, total surplus in each given mode is

$$W = G\left(\tilde{u}(\lambda^*)\right)\left[\tilde{u}(\lambda^*) + A \cdot I_{\{not\ M\}} + a + v(\lambda^*) \cdot I_{\{not\ D\}}\right] + \int_{\tilde{u}(\lambda^*)}^{\infty} x g(x) dx - C \cdot I_{\{not\ M\}},$$

where $\tilde{u}(.)$ is replaced with $\tilde{u}_0(.)$ in the pure membership mode.

Intuitively, the trade-offs in W can be understood as follows. First, the introduction of a membership portal (i.e., $I_{\{not\ D\}} = 1$) enables the surplus from the exclusive content to be realized. Second, the introduction of discovery portal (i.e., $I_{\{not\ M\}} = 1$) weakly reduces search cost while allowing the surplus from platform advertising to be realized. Finally, both of these affect the creators' equilibrium design, thus affecting consumer search reservation $\tilde{u}(\lambda^*)$. To see these more clearly, let us consider the case where G is highly inelastic whereby all changes in W happen on the intensive margin.[28] Then,

$$W_H - W_D = \underbrace{\tilde{u}(\lambda_H^*) - \tilde{u}(\lambda_D^*)}_{\text{decrease in search reservation value}} + \underbrace{v(\lambda_H^*)}_{\text{exclusive content surplus enabled}},$$

and so $W_H > W_D$ as long as the hybrid mode does not reduce consumer search reservation too

[28] Allowing for elastic $G(\cdot)$ does not qualitatively change the observations below because the extensive margin depends purely on $\tilde{u}(\lambda)$. Such a change simply results in a greater weight on the $\tilde{u}(\lambda)$ component for the welfare comparisons.

much relative to the exclusive content surplus that it enables. Likewise,

$$W_H - W_M = \underbrace{\tilde{u}(\lambda_H^*) - \tilde{u}_0(\lambda_M^*)}_{\text{increase in search reservation value}} + \underbrace{v(\lambda_H^*) - v(\lambda_M^*)}_{\text{decrease in exclusive content surplus}} + \underbrace{A - C}_{\text{advertising surplus enabled}}.$$

Thus, $W_H > W_M$ as long as the hybrid mode does not reduce exclusive content surplus too much.

We are interested in whether the platform's choice of business model aligns with the total surplus ranking. To explore this, we continue from our numerical examples in Figure 2. In Figure 3 below, we identify parameter regions where the business model with the highest equilibrium profit coincide with the socially optimal business model (white and dark gray).

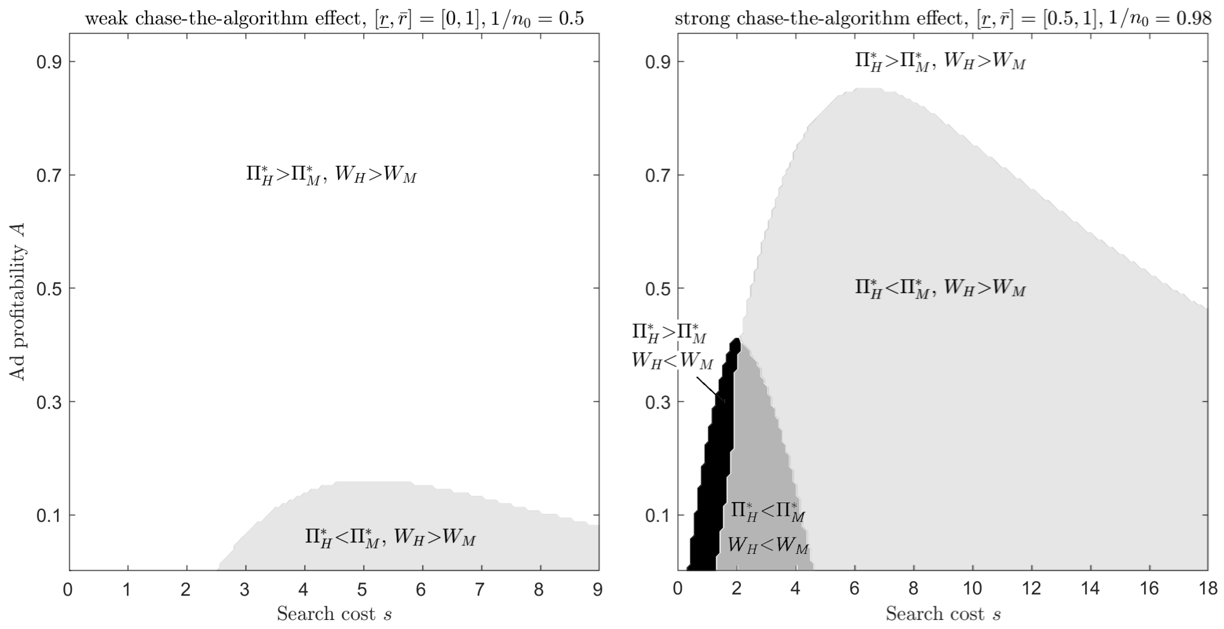

Figure 3: Alignment of business models. The parameter configuration is the same as that in Figure 2. Light gray and black regions indicate profit incentives misaligned with welfare maximization.

In the first panel (weak chase-the-algorithm effect), for all A and s, we have $W_H > W_M$ due to the increase in search reservation value enabled by the discovery portal; and also $W_H > W_D$ due to the exclusive content surplus enabled by the membership portal. In this case, there is no misalignment in the white region, whereby the hybrid mode always corresponds to the highest equilibrium profit and total surplus. However the platform "under-adopts" the hybrid mode in the light gray region where $\Pi_H^* < \Pi_M^*$, reflecting that it does not fully internalize the increase in consumers' search reservation value that the hybrid mode enables.

In the second panel (strong chase-the-algorithm effect), the parameters are chosen to dampen the increase in search reservation value that the hybrid mode enables, so that we have $W_H < W_M$ in the bottom-left region (dark gray and black). Nonetheless, as long as s is not too small, we observe that that the platform still does not "over-adopt" the hybrid mode (i.e., in the dark gray region where $\Pi_H^* < \Pi_M^*$). This reflects that most of the surpluses from the pure membership mode are captured by the platform from a distributional perspective, given that users prefer the pure membership mode the least by Corollary 3. Meanwhile, over-adoption of the hybrid mode arises only in the relatively narrow black strip where the search cost is low.[29]

One limitation of our approach is that the reduced form nature of functions $u(\cdot)$ and $v(\cdot)$ ignores the creators' allocation of time and effort between exclusive content and ads or sponsored content. Hypothetically, an increase in τ could harm consumers by causing the creators to lower the quality of exclusive content, change their pricing for exclusive content, or to seek more external sponsorships. This effect is explored elsewhere in the literature (Fainmesser and Galeotti 2021; Pei and Mayzlin 2022; Andres, Rossi, and Tremblay 2023; Janssen and Williams 2023) so we choose not to focus on it here.

Endogenous ad and revenue instruments

The benchmark model has assumed that each visiting consumer generates a fixed ad revenue A to the discovery portal, which it does not share with the creators. Suppose now the discovery portal can choose (i) $p \geq 0$, the amount of ads to display on the platform, which consumers view as a nuisance; and (ii) the ad revenue sharing, where the platform's share is $f \in [0,1]$ whereas the creators' share is $1-f$. By alternatively interpreting p as access prices, this setup also captures platforms that charge consumers a platform-wide access price and share the revenue with creators (e.g., Medium, Skillshare, and Nebula in Table 1).

Formally, we rewrite the platform's profit in the hybrid mode (the pure discovery mode profit can be rewritten analogously) as:

$$\Pi_H(p,f,r,\tau) = G\left(\tilde{u}\left(\lambda_H\right) - p\right)\left(fpA + \tau v\left(\lambda_H\right)\right) - C$$

where parameter A now captures the per-ad revenue (profitability of ads) and we normalize the per-ad nuisance cost perceived by consumers to 1. Meanwhile, the equilibrium design of creators in (6) now becomes

$$\lambda^* = \arg\max_{\lambda_i \in [0,1]} \left\{ D\left(\frac{\tilde{u}(\lambda_i)}{1-r}, \frac{\tilde{u}(\lambda^*)}{1-r}\right)\left(a + (1-f)pA + (1-\tau)v\left(\lambda_i\right)\right)\lambda_i \right\}$$

[29] In addition to the surplus comparisons above, an alternative welfare analysis would be to examine potential distortion in the equilibrium for each given business model. In Section C of the Online Appendix, we find that the signs of such distortions are ambiguous in general.

If $p = 0$ and $f = 1$, then we recover a special case of the benchmark model with $A = 0$.

Observe that λ^* is increasing in $(1 - f)p$, i.e., the ad revenue received by the creators. Hence, the platform has an additional avenue to affect equilibrium content design. Whenever the platform operates a discovery portal, it faces the following trade-off: increasing f and p increases the per-viewer revenue obtained by the platform itself but it may potentially decrease platform viewership $G(\tilde{u}(\lambda^*) - p)$ through changes in design.

Clearly, this amendment affects only the pure discovery mode and the hybrid mode. In Section D of the Online Appendix, we show that Proposition 2 remains valid with redefined thresholds on A, whereas Proposition 3 holds if $\bar{r} \to 1$ (i.e., the discovery portal can induce $\max_{\lambda_i} \tilde{u}(\lambda_i)$ if it wants to). Moreover, if $\bar{r} \to 1$, both the pure discovery mode and hybrid mode have $f = 1$, consistent with the assumption in the benchmark model. Intuitively, the only potential downside of raising f is it reduces $\tilde{u}(\lambda^*)$ and viewership. However, if $\bar{r} \to 1$, the platform can fully negate this downside by raising r accordingly to induce a higher $\tilde{u}(\lambda^*)$, and so it is profitable for the platform to keep increasing f until the boundary constraint $f \leq 1$ binds.

7 Discussion and conclusion

This article presents a tractable model of a platform-intermediated content creation market to analyze three distinct platform business models: pure discovery mode, pure membership mode, and hybrid mode. Our results yield several implications that can help to inform strategic business model decisions of platforms in the creator economy. Importantly, these insights are driven by creators' endogenous content design responses to the platforms' decisions.

First, an existing pure discovery platform can always benefit from introducing a membership portal (thus going hybrid) and choosing an appropriate level of commission if it is a monopolist. However, this is not necessarily true when the platform faces a competing platform that operates a membership portal as the competition in platform commissions creates a negative spillover on the platform's existing advertising revenue.

Second, an existing pure membership platform does not always benefit from introducing a discovery portal. Doing so distracts creators from focusing on raising the value of their exclusive content (thus harming the platform's commission revenue) due to the competition for recommendations. Reflecting this profit concern, the platform may fail to introduce a discovery portal when doing so increases total surplus in the market.

Third, strategic differentiation in platform business models can arise in the equilibrium in which one platform operates in pure discovery mode while the other is pure membership or hybrid, as summarized in Figure 4 below (based on discussions in Section 5). On the horizontal axis of the figure, asymmetric business models emerge when the competition in transaction commission among membership portals is sufficiently intense. Symmetric business models appear when the reverse is true. On the vertical axis, platforms focus more on membership portals when advertising revenue becomes less available.[30]

	Strong commission competition (e.g. complete multihoming)	Weak commission competition (e.g. competitive bottleneck or strong horizontal differentiation)
High ad profit	Pure discovery+Hybrid	Hybrid+Hybrid
Medium ad profit	Pure discovery + Pure membership	Hybrid+Pure membership
Low ad profit		Pure membership + Pure membership

Figure 4: The equilibrium market structure.

In terms of possible future directions, we note that our model currently focuses on the impact of different business modes on content creators' design choices, but there are other questions which could be investigated with this framework. First, algorithm quality investment is highly relevant to competition between discovery portals. Tiktok's main selling point is arguably its ability to recommend compelling content to consumers. We expect that such a setting would lead to a Bertrand style competition in investment, thus inducing more strategic differentiation of business models in this context. Second, we could consider whether there is a symbiotic relationship between pure discovery or hybrid and pure membership platforms. Patreon arguably benefits significantly from YouTube's discovery portal, whereas YouTube benefits from more content without having to directly compensate the relevant creators.[31] Finally, expanding the idea of "chasing the algorithm" to allow changing content types could cause creators to shift content types away from what they are most interested or best able to produce. This effect would likely lead to a vertical reduction in the quality of content produced relative to a world with a weaker chase the algorithm effect.

[30] For example, the short form videos on Tiktok are much less conducive to selling advertisements than the longer videos on YouTube, and Tiktok has a commensurately greater emphasis on enabling creators to monetize their audiences directly. Green (2023) provides a detailed video discussion of this tradeoff from an industry insider perspective.

[31] This symbiosis can be explored further by using alternative approaches to model elastic creator participation. In this case, we expect that entry by a pure membership platform in a market with a pure discovery platform would lead to more participation by niche creators and less importance of "superstar" creators in these platforms (Carroni, Madio, and Shekhar 2023).

At a high level, our article also echoes the recent interest in understanding the social implications of different business models of digital platforms (Caffarra et al. 2020). The growing prominence of content platforms like Youtube and Facebook as sources for media consumption, means that these platforms have considerable influence on the type of media content being created. We identify conditions under which changes in platform business model increase or decrease the equilibrium level of content broadness chosen by the creators. These implications are empirically testable in principle if a proper notion of "content broadness" can be defined (see, e.g., Gong (2021)).

A Appendix: microfoundation for recommendation function

Consider the following modification to the consumer utility, which make explicit the information assumptions regarding consumers and platform. As will be shown below, the formulation is formally equivalent to the model in Section 3 after appropriate renormalization. Consider a consumer j with type t_j. Each creator with type $t_i \neq t_j$ delivers zero utility $u_{ij} = 0$ to consumer j, whereas a creator with type $t_i = t_j$ delivers utility

$$u_{ij} = u(\lambda_i) + \eta_{ij} + \epsilon_{ij}, \tag{A.1}$$

where:

- The term $u(\lambda_i)$ follows the same specification as in Section 3 and it is observed by the consumer only after inspection.
- With probability λ_i, $\eta_{ij} = 0$; with probability $1 - \lambda_i$, $\eta_{ij} = -\infty$. Notice that if the term ϵ_{ij} is absent, then this specification on η_{ij} means (A.1) is equivalent to (1). The realization of η_{ij} is observed only by the consumer and only after inspection.
- The component ϵ_{ij} is a pair-ij-specific idiosyncratic factor that is i.i.d. according to a log-concave CDF function H. It reflects an experience component and so the consumer does not observe its realization after inspection.

At the point of recommendation to each consumer j, the platform observes, for each creator i, the design λ_i and an imperfect signal v_{ij} on the realization of ϵ_{ij}, but observes nothing about the realization of η_{ij}. This formulation reflects that the platform can estimate from past engagement behaviors of all viewers (e.g., clicks, viewing time, comments, number of likes, and other attributes) how good creator i is for consumer j, but the platform is ultimately unsure whether consumer j will stop searching and become a viewer of creator i.

Based on the available information, the platform provides a truthful recommendation to consumers (which guarantees that consumers follow recommendations). By Pandora's rule, the platform recommends

i to a consumer of type t_i whenever i has the highest search reservation value among the creators of the same type:

$$\tilde{u}(\lambda_i) + E[\epsilon_{ij}|v_{ij}] = u(\lambda_i) - \frac{s}{\lambda_i} + E[\epsilon_{ij}|v_{ij}].$$

To obtain the expressions when there is a continuum consumers and creators of type t_i (both of mass $1/n_0$), we start by considering the case of a large finite number K of consumers and creators of this type. Then, we obtain the limiting case by letting $K \to \infty$. From creators' perspective, the probability that creator i is recommended to a given consumer is

$$\mathcal{P} = \Pr\left(\tilde{u}(\lambda_i) + E[\epsilon_{ij}|v_{ij}] \geq \max_{k\in T_i, k\neq i}\{\tilde{u}(\lambda_k) + E[\epsilon_{kj}|v_{kj}]\}\right) \tag{A.2}$$

where the probability is taken with respect to v_{ij} and v_{kj}.

Let the imperfect signal v_{ij} follow the truth-or-noise structure from Lewis and Sappington (1994), i.e.,

$$v_{ij} = \left\{\begin{array}{cc} \epsilon_{ij} & \text{with probability } 1-r \\ \text{an iid draw from } H & \text{with probability } r \end{array}\right\},$$

where $r \in [0, 1)$ is chosen by the platform and it can be understood as a noise parameter with respect to the accuracy of signal v_{ij} in reflecting the idiosyncratic experience utility component ϵ_{ij}. An interpretation here is that platform chooses and commits to how it obtains the signal v_{ij} on consumer idiosyncratic experience utility, where the signal structure is parameterized by index r. A lower r corresponds to having more information on consumer specific preferences, whereas $r = 1$ corresponds to completely noisy signals (and $r = 0$ correspond to perfectly informative signal).

The truth-or-noise structure implies $E[\epsilon_{ij}|v_{ij}] = (1-r)v_{ij} + rE[\epsilon_{ij}]$. Then, (A.2) simplifies to

$$\mathcal{P} = \Pr\left(\frac{\tilde{u}(\lambda_i)}{1-r} + v_{ij} \geq \max_{k\in T_i, k\neq i}\left\{\frac{\tilde{u}(\lambda_k)}{1-r} + v_{kj}\right\}\right). \tag{A.3}$$

In the case of H following the Type-1 extreme value distribution with scale parameter normalized to one, (A.3) becomes the standard logit probability

$$\mathcal{P} = \frac{\exp\left(\frac{\tilde{u}(\lambda_i)}{1-r}\right)}{\sum_{k\in T_i}\exp\left(\frac{\tilde{u}(\lambda_k)}{1-r}\right)}.$$

Then, the expected number of consumers who are recommended with i is $K \times \mathcal{P}$. In the limiting case, a standard argument (Anderson and Bedre-Defolie 2023, Theorem 1) shows

$$\lim_{K\to\infty}\frac{K\exp\left(\frac{\tilde{u}(\lambda_i)}{1-r}\right)}{\sum_{k\in T_i}\exp\left(\frac{\tilde{u}(\lambda_k)}{1-r}\right)} = \frac{\exp\left(\frac{\tilde{u}(\lambda_i)}{1-r}\right)}{\int_{k\in T_i}\exp\left(\frac{\tilde{u}(\lambda_k)}{1-r}\right)} \equiv D\left(\frac{\tilde{u}(\lambda_i)}{1-r}; \frac{\tilde{u}(\lambda_{-i})}{1-r}\right),$$

which is consistent with expression (2) and logit expression (5). Hence, we have obtained a discrete-choice microfoundation to the recommendation function $D(\cdot;\cdot)$.

For other general distributions of H, we can utilize the symmetry between creators. Denote $\hat{H}(\cdot; K)$ as the CDF of random variable $v_{ij} - \max_{k \in T_i, k \neq i}\{v_{kj}\}$, which depends on the underlying distribution H and the number of creators K in set T_i. Imposing symmetry where all creators $k \neq i$ chooses $\lambda_k = \lambda$, we get

$$\mathcal{P} = \Pr\left(v_{ij} - \max_{k \in T_i, k \neq i}\{v_{kj}\} \geq \frac{\tilde{u}(\lambda) - \tilde{u}(\lambda_i)}{1-r}\right) = 1 - \hat{H}(\frac{\tilde{u}(\lambda) - \tilde{u}(\lambda_i)}{1-r}; K)$$

Then, the expected number of consumers who are recommended with i is $(1-\hat{H}) \times K$, and we obtain expression (2) as the limiting case: $D = \lim_{K \to \infty}\{(1-\hat{H}) \times K\}$.

Finally, we need to describe the consumer participation decision (i.e., whether to initiate search) in this environment. Given that consumers do not observe ϵ_{ij}, their search decisions are based on the on-equilibrium path expected value of ϵ_{ij}. In the symmetric equilibrium, the recommendation rule above implies a creator i is recommended if and only if $i = \arg\max_i \{v_{ij}\}$, and so the ex-ante expected value is $E[\epsilon_{ij} | i = \arg\max_{i \in T_i}\{v_{ij}\}]$. Using the truth-or-noise structure, we get

$$\begin{aligned} E[\epsilon_{ij} | i = \arg\max_{i \in T_i}\{v_{ij}\}] &= E[\max_{i \in T_i} E[\epsilon_{ij} | v_{ij}]] \\ &= (1-r)E[\max_{i \in T_i}\{\epsilon_{ij}\}] + rE\left[\epsilon_{ij}\right], \end{aligned}$$

which is decreasing in r. That is, consumers would obtain a lower expected experience utility component from participating when the platform's signal structure (or recommendation) is less accurate in reflecting consumer idiosyncrasies. To streamline the microfoundation, we assume that consumers face a privacy cost

$$\kappa(r) = (1-r)\left(E[\max_{i \in T_i}\{\epsilon_{ij}\}] - E\left[\epsilon_{ij}\right]\right) \geq 0.$$

which increases when the platform's signal structure (or recommendation) is more accurate, i.e., a lower r. Therefore, a consumer participates if and only if

$$\begin{aligned} x_j &\leq \tilde{u}(\lambda^*) + E[\epsilon_{ij} | i = \arg\max_{i \in T_i}\{v_{ij}\}] - \kappa(r) \\ &= \tilde{u}(\lambda^*) + E\left[\epsilon_{ij}\right] \end{aligned}$$

where recall x_j is the outside option of consumer j. Then, renormalizing the distribution support of G by the constant factor $E\left[\epsilon_{ij}\right]$, the mass of consumers who search is $\Pr(x - E\left[\epsilon_{ij}\right] \leq \tilde{u}(\lambda^*)) \equiv G(\tilde{u}(\lambda^*))$, as in Lemma 1.

B Appendix: proofs

Proof. (**Lemma 1**). To complete the equilibrium construction discussed in the main text, it remains to verify creators' lack of incentive to deviate to $\lambda_i \neq \lambda^*$ taking into account consumers' search decisions off the equilibrium path. Denote

$$\pi\left(\lambda_i\right) = D\left(\frac{\tilde{u}(\lambda_i)}{1-r};\frac{\tilde{u}(\lambda^*)}{1-r}\right)\lambda_i\left(a+(1-\tau)v\left(\lambda_i\right)\right)$$

Suppose a consumer has inspected creator i. If there is no match in taste, the consumer continues her search. Otherwise, she observes utility $u\left(\lambda_i\right)$ and stops if and only if $u\left(\lambda_i\right) > u(\lambda^*) - \frac{s}{\lambda^*}$. For any $\lambda_i \neq \lambda^*$, one of the two cases occur: (i) if $u(\lambda_i) \geq \tilde{u}(\lambda^*)$ then consumers who draw a taste match stop searching, but expected creator profit is $\pi\left(\lambda_i\right) \leq \pi\left(\lambda^*\right) \equiv \max_{\lambda_i}\pi\left(\lambda_i\right)$; or (ii) if $u(\lambda_i) < \tilde{u}(\lambda^*)$ then even consumers who draw a taste match continue searching, so that creator profit is zero. Hence, there is no strict incentive to deviate from $\lambda_i = \lambda^*$. ■

Proof. (**Proposition 1**). Holding r and τ fixed, λ^* as the solutions to FOC

$$0 = \frac{1}{\lambda^*} + \frac{1}{1-r}\frac{D'}{D}\frac{\partial\tilde{u}}{\partial\lambda_i} + \frac{(1-\tau)v'(\lambda^*)}{a+(1-\tau)v(\lambda^*)}.$$

Notice that symmetry and close coverage of recommendations imply D'/D is an exogenous constant. By total differentiation, we know $\partial\lambda^*/\partial r$ has the same sign as

$$\frac{\partial\tilde{u}}{\partial\lambda_i} = u'(\lambda^*) + \frac{s}{(\lambda^*)^2}.$$

Note this immediately implies $\tilde{u}(\lambda^*(r,\tau))$ is always increasing in r. Next, observe that if $s\to 0$ then $\partial\tilde{u}/\partial\lambda_i$ becomes negative (and thus $\partial\lambda^*/\partial r \leq 0$); whereas if $s\to\infty$ then $\partial\tilde{u}/\partial\lambda_i$ becomes positive (and thus $\partial\lambda^*/\partial r \geq 0$). Hence, the claimed threshold exists by the intermediate value theorem, which we denote as $\bar{s}$, and it remains to establish its uniqueness, which follows from $\frac{\partial^2\tilde{u}}{\partial\lambda_i\partial s} > 0$. Likewise, $\partial\lambda^*/\partial\tau$ has the same sign as

$$\frac{\partial}{\partial\tau}\left(\frac{(1-\tau)v'(\lambda_i)}{a+(1-\tau)v(\lambda_i)}\right)_{\lambda_i=\lambda^*} = \frac{-av'(\lambda^*)}{\left(a+(1-\tau)v(\lambda^*)\right)^2} \geq 0.$$

■

To prove Propositions 2 and 3, recall from Lemma 1 that $\partial\lambda^*/\partial\tau \geq 0$ (with the inequality strict whenever $\lambda^* \in (0,1)$) whereas $\partial\lambda^*/\partial r$ has the same sign as $\partial\tilde{u}/\partial\lambda_i$. Then, we note the following two claims:

Claim 1. *Define*

$$\hat{\tau}(r,A) \equiv \arg\max_{\tau} G\left(\tilde{u}(\lambda(r,\tau))\right)\left(A+\tau v(\lambda^*(r,\tau))\right) \quad \textit{for any given } r \geq 0. \tag{B.1}$$

Then, there exist thresholds $A'_{mono} \geq 0$ and $B'_{mono} \geq 0$ such that:

- *If $s \geq \bar{s}_{\max}$, then $\hat{\tau}(r, A)$ is increasing in A. Moreover, $\hat{\tau}(-\infty, A) \geq \tau_M^*$ if and only if $A \geq A'_{mono}$.*
- *If $s \leq \bar{s}_{\min}$, then $\hat{\tau}(r, A)$ is decreasing in A. Moreover, $\hat{\tau}(-\infty, A) \leq \tau_M^*$ if and only if $A \geq B'_{mono}$.*
- *If $n_0 \to 1$, then $A'_{mono} \to 0$ and $B'_{mono} \to 0$.*

Proof. **(Claim 1).** The first-order condition associated with (B.1) is

$$\frac{G\left(\tilde{u}\left(\lambda^*\right)\right)}{g\left(\tilde{u}\left(\lambda^*\right)\right)}\left(v(\lambda^*)+v'(\lambda^*)\tau\frac{\partial\lambda^*}{\partial\tau}\right)+\left(A+\tau v(\lambda^*)\right)\frac{\partial\tilde{u}}{\partial\lambda_i}\frac{\partial\lambda^*}{\partial\tau}=0, \tag{B.2}$$

so that $\partial\hat{\tau}(r, A)/\partial A$ has the same sign as $\partial\tilde{u}/\partial\lambda_i$. Suppose $s \leq \bar{s}_{\min}$ so that $\tilde{u}(\lambda_i)$ is monotone decreasing, then $d\hat{\tau}(r, A)/dA$ has the same sign as $\partial\tilde{u}/\partial\lambda_i \leq 0$. Given that this holds for arbitrary r, we have $\hat{\tau}(-\infty, A) < \hat{\tau}(-\infty, 0)$. Furthermore, $\lim_{A\to\infty}\hat{\tau}(-\infty, A) = 0 > \tau_M^*$. Therefore, if $\tau_M^* < \hat{\tau}(-\infty, 0)$, then the intermediate value theorem implies the existence of the threshold $B'_{mono} \in (0, \infty)$ Otherwise, if $\tau_M^* \geq \hat{\tau}(-\infty, 0)$, then we set $B'_{mono} = 0$. Observe that if $n_0 \to 1$, then $\tilde{u} = \tilde{u}_0$ and so $\tau_M^* = \hat{\tau}(-\infty, 0)$, implying $B'_{mono} = 0$. The case of $s \geq \bar{s}_{\max}$ and threshold A'_{mono} can be established similarly, hence omitted here. ∎

Claim 2. *The total derivative $\frac{d}{dr}\lambda^*(r, \hat{\tau}(r, A))$ is weakly negative if $s \leq \bar{s}_{\min}$, and weakly positive if $s \geq \bar{s}_{\max}$, where $\hat{\tau}(r, A)$ is defined in (B.1).*

Proof. **(Claim 2).** We will focus on the case of $s \leq \bar{s}_{\min}$ so that $\tilde{u}(\lambda_i)$ is monotone decreasing. The same proof applies when $s \geq \bar{s}_{\max}$. In what follows, we omit the argument A, and write

$$\frac{d}{dr}\lambda^*(r, \hat{\tau}(r)) = \underbrace{\frac{\partial\lambda^*(r, \hat{\tau}(r))}{\partial\tau}}_{>0 \text{ (Proposition 1)}}\frac{d\hat{\tau}}{dr} + \underbrace{\frac{\partial\lambda^*(r, \hat{\tau}(r))}{\partial r}}_{\text{same sign as } \partial\tilde{u}/\partial\lambda_i}.$$

To evaluate $d\hat{\tau}/dr$, we express the left-hand side of FOC (B.2) as

$$\Psi\left(\lambda, r, \tau\right) = \frac{G\left(\tilde{u}\left(\lambda\right)\right)}{g\left(\tilde{u}\left(\lambda\right)\right)}v(\lambda) + \left(v'(\lambda)\tau\frac{G\left(\tilde{u}\left(\lambda\right)\right)}{g\left(\tilde{u}\left(\lambda\right)\right)} + \left(A+\tau v(\lambda)\right)\frac{\partial\tilde{u}}{\partial\lambda_i}\right)\frac{\partial\lambda^*}{\partial\tau}. \tag{B.3}$$

Then, totally differentiating (B.2) gives

$$\frac{d\hat{\tau}}{dr} = \frac{\frac{\partial\Psi}{\partial\lambda}\frac{\partial\lambda^*(r,\hat{\tau})}{dr}+\frac{\partial\Psi}{\partial r}}{-\frac{\partial\Psi}{\partial\lambda}\frac{\partial\lambda^*(r,\hat{\tau})}{d\tau}-\frac{\partial\Psi}{\partial\tau}}|_{\tau=\hat{\tau}} \tag{B.4}$$

Notice the denominator is positive by the local stability condition of $\hat{\tau}$ being an interior solution associated with (B.2). We know $\frac{d}{dr}\lambda^*(r, \hat{\tau}(r)) \leq 0$ is true if (B.4) is bounded above by $-\frac{\partial\lambda^*(r,\hat{\tau})/\partial r}{\partial\lambda^*(r,\hat{\tau})/\partial\tau}$, which is equivalent to (where all terms are evaluated at $\tau = \hat{\tau}$)

$$\frac{\partial\Psi}{\partial r} \leq \frac{\partial\Psi}{\partial\tau}\underbrace{\left(\frac{\partial\lambda^*(r,\hat{\tau})/\partial r}{\partial\lambda^*(r,\hat{\tau})/\partial\tau}\right)}_{\leq 0}, \tag{B.5}$$

which holds if derivatives $\frac{\partial \Psi}{\partial r}|_{\tau=\hat{\tau}}$ and $\frac{\partial \Psi}{\partial \tau}|_{\tau=\hat{\tau}}$ are both weakly negative (i.e., holding λ fixed). These are straightforward to establish from the definition of $\Psi(\lambda, r, \tau)$ in (B.3) using

$$\frac{\partial \lambda^*}{\partial \tau}|_{(\lambda,r,\tau)} = \frac{(1-r)\frac{a}{(1-\tau)^2} + \frac{D'}{D}\left(\lambda u'(\lambda) + \frac{s}{\lambda^*}\right)\frac{a}{(1-\tau)^2}}{(1-r)\left(\lambda v''(\lambda) + v'(\lambda)\right) + \frac{D'}{D}\left(\lambda u'(\lambda) + \frac{s}{\lambda}\right)v'(\lambda) + \frac{D'}{D}\left(u'(\lambda) + \lambda u''(\lambda) - \frac{s}{\lambda^2}\right)\left(\frac{a}{1-\tau} + v(\lambda)\right)} \geq 0.$$

■

Proof. **(Proposition 2).** The envelope theorem implies $\Pi_H^* - \Pi_M^*$ is monotone increasing in A. The intermediate value theorem and implicit function theorem together prove the existence and uniqueness of threshold $A_{mono} \geq 0$ (if $\Pi_H^* > \Pi_M^*$ for all $A \geq 0$, then we set $A_{mono} = 0$).

Suppose $s \geq \bar{s}_{\max}$ so that $\tilde{u}(\lambda_i)$ that is monotone increasing, then we have $A_{mono} > 0$ if G is sufficiently inelastic. To see this, note if $A = 0$ and $G(.)$ is a constant, then

$$\begin{aligned}
\Pi_H^* &= G \times \tau_H^* v(\lambda^*(r_H^*, \tau_H^*)) - C \\
&< G \times \tau_H^* v(\lambda^*(-\infty, \tau_H^*)) - C \\
&\leq G \times \tau_M^* v(\lambda^*(-\infty, \tau_M^*)) = \Pi_M^*.
\end{aligned}$$

where the first inequality follows from $v(.)$ being decreasing and $\partial\lambda^*/\partial r > 0$ (implied by $\tilde{u}(\lambda_i)$ being monotone increasing), and the second inequality follows from the definition of τ_M^* and $C \geq 0$. Suppose $s \leq \bar{s}_{\max}$ so that $\tilde{u}(\lambda_i)$ that is monotone decreasing. Clearly, $r_H^* = \bar{r}$ in this case because Π_H is now monotone increasing in r. Then,

$$\begin{aligned}
\Pi_H^* &= G\left(\tilde{u}\left(\lambda^*(\bar{r}, \tau_H^*)\right)\right)\left(A + \tau_H^* v(\lambda^*(\bar{r}, \tau_H^*))\right) - C \\
&\geq G\left(\tilde{u}\left(\lambda^*(\bar{r}, \tau_M^*)\right)\right)\left(A + \tau_M^* v(\lambda^*(\bar{r}, \tau_M^*)\right) - C \\
&\geq G\left(\tilde{u}\left(\lambda^*(\bar{r}, \tau_M^*)\right)\right)\tau_M^* v(\lambda^*(\bar{r}, \tau_M^*) \\
&\geq G\left(\tilde{u}\left(\lambda^*(-\infty, \tau_M^*)\right)\right)\tau_M^* v(\lambda^*(-\infty, \tau_M^*)) \\
&\geq G\left(\tilde{u}_0\left(\lambda^*(-\infty, \tau_M^*)\right)\right)\tau_M^* v(\lambda^*(-\infty, \tau_M^*)) = \Pi_M^*.
\end{aligned}$$

where the first inequality follows from the definition of τ_H^*; the second inequality follows from the cost condition in footnote 13 and $\tilde{u}\left(\lambda^*(\bar{r}, \tau_M^*)\right) \geq \tilde{u}\left(\lambda^*(\bar{r}, 1)\right)$ in this case; the third inequality follows from $v(.)$ being decreasing and $\partial\lambda^*/\partial r < 0$ (implied by $\tilde{u}(\lambda_i)$ being monotone decreasing); and the last from $\tilde{u}_0(\lambda_i) < \tilde{u}(\lambda_i)$.

To prove the results on the equilibrium design, suppose $s \leq \bar{s}_{\max}$ so that $\frac{d}{dr}\lambda^*(r, \hat{\tau}(r, A)) \leq 0$ by Claim 2. Then, using Claim 1, $A \geq B'_{mono}$ would imply $\lambda^*(r, \hat{\tau}(r, A)) \leq \lambda^*(-\infty, \hat{\tau}(-\infty, A))$, which is smaller than $\lambda^*(-\infty, \tau_M^*) = \lambda_M^*$, implying $\lambda_H^* \leq \lambda_M^*$. Suppose $s \geq \bar{s}_{\max}$ so that $\frac{d}{dr}\lambda^*(r, \hat{\tau}(r, A)) \geq 0$ by Claim 2.

Then, using Claim 1, $A \geq A'_{mono}$ would imply $\lambda^*(r, \hat{\tau}(r, A)) \geq \lambda^*(-\infty, \hat{\tau}(-\infty, A))$, which is greater than $\lambda^*(-\infty, \tau_M^*) = \lambda_M^*$, implying $\lambda_H^* \geq \lambda_M^*$. ■

Proof. **(Proposition 3).** The profit comparison follows from a revealed preference argument:

$$\begin{aligned} \Pi_D^* + C &= G(\tilde{u}(\lambda^*(r_D^*, 1)))A \\ &< G(\tilde{u}(\lambda^*(r_D^*, 1)))(A + v(\lambda^*(r_D^*, 1))) \leq \Pi_H^* + C. \end{aligned}$$

To prove $\lambda_H^* \leq \lambda_D^*$, suppose by contradiction $\lambda_H^* = \lambda^*(r_H^*, \tau_H^*) > \lambda^*(r_D^*, 1) = \lambda_D^*$. Then by Proposition 1 we know $\lambda^*(r_H^*, 1) \geq \lambda^*(r_H^*, \tau_H^*) > \lambda^*(r_D^*, 1)$. By the intermediate value theorem and continuity of $\lambda^*(., 1)$, there exists $\tilde{r} \in [r_H^*, r_D^*]$ (recall $r_D^* = \bar{r}$) such that $\lambda^*(\tilde{r}, 1) = \lambda^*(r_H^*, \tau_H^*)$. Then

$$\tilde{u}(\lambda^*(r_H^*, \tau_H^*)) = \tilde{u}(\lambda^*(\tilde{r}, 1)) \leq \max_r \{\tilde{u}(\lambda^*(r, 1))\} = \tilde{u}(\lambda^*(r_D^*, 1)). \tag{B.6}$$

Then, inequality (B.6), together with the initial supposition of $\lambda^*(r_H^*, \tau_H^*) > \lambda^*(r_D^*, 1)$ and $v(.)$ being decreasing, implies a contradiction to optimality of (r_H^*, τ_H^*):

$$\begin{aligned} \Pi_H^* &= G(\tilde{u}(\lambda^*(r_H^*, \tau_H^*)))(A + \tau_H^* v(\lambda^*(r_H^*, \tau_H^*))) \\ &< G(\tilde{u}(\lambda^*(r_D^*, 1)))(A + v(\lambda^*(r_D^*, 1))) = \Pi_H(r_D^*, 1) \end{aligned}$$

■

Proof. (**Proposition 4 and Proposition 5).** We first make two observations: (i) Bertrand competition between two homogeneous membership portal components to attract creators implies $\tau_1 = \tau_2 = 0$; (ii) Bertrand competition between two homogeneous discovery portal components to attract consumer search (and to earn the platform advertising revenue $A > 0$) implies $r_1 = r_2 = \bar{r}$. There is no incentive to deviate by lowering r_l or raising τ_l because that doing so does not affect creators' content design and hence does not affect consumers' search decisions (Lemma 2). Given that platforms are ex ante symmetric, we let $l = 2$ and $-l = 1$ without loss of generality.

In the following, $\lambda^* = \lambda^*(r, \tau)$ is given by Lemma 2. Note that assumption $s > \bar{s}_{max}$ and Proposition 1 together imply $\lambda^*(r, \tau)$ is increasing in τ and r, whereas $\tilde{u}(\cdot)$ is an increasing function.

Case 1: $P_1 = M$**.** If $P_2 = D$, let $\tau_{MD} > 0$ be the equilibrium commission of platform 1 in this subgame (the alphabetical subscript denotes the mode choices of P_1 and P_2 in successive order). Then, platform P_2 earns

$$\Pi_{2,MD}^* = G(\tilde{u}(\lambda^*(r_{MD}, \tau_{MD})))A - C > 0,$$

where

$$r_{MD} = \arg\max_{r \in [\underline{r}, \bar{r}]} \tilde{u}(\lambda^*(r, \tau_{MD})) = \bar{r}.$$

and the inequality is due to the cost condition in footnote 13. If $P_2 = M$, the Bertrand logic implies $\tau_1 = \tau_2 = 0$ so that $\Pi_{2,MM} = 0 < \Pi_{2,MD}$. If $P_2 = H$, $\tau_1 = \tau_2 = 0$ so

$$\Pi_{2,MH} = G\left(\tilde{u}(\lambda^*(r_{MH}, 0))\right) A - C < G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{MD}))\right) A - C = \Pi_{2,MD}.$$

Hence, $P_2 = D$ is the best response.

Case 2: $P_1 = H$. If $P_2 = M$, we know $\tau_1 = \tau_2 = 0$ and so $\Pi_{2,HM} = 0$. If $P_2 = D$, we know $r_1 = r_2 = \bar{r}$, and so

$$\Pi_{2,HD} = G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD}))\right) \frac{A}{2} - C,$$

where $\tau_{HD} > 0$ whereas the advertisement revenue $A/2$ reflects that consumers split between searching through the discovery portals of the two platforms. Notice the cost condition in footnote 13 does not imply $\Pi_{2,HD} > 0$ given that $A/2 < A$. Define

$$A'_{MH} = \frac{2C}{G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD})\right)} \tag{B.7}$$

so that $\Pi_{2,HD} \geq 0 = \Pi_{2,HM}$ if and only if $A \geq A'_{MH}$. It remains to show $P_2 = H$ is never a best response. When $P_1 = P_2 = H$, we know $r_1 = r_2 = \bar{r}$ and $\tau_1 = \tau_2 = 0$, so that

$$\Pi_{2,HH} = G\left(\tilde{u}(\lambda^*(\bar{r}, 0))\right) \frac{A}{2} - C < G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD}))\right) \frac{A}{2} - C = \Pi_{2,HD}.$$

given that $\tilde{u}(\lambda^*)$ is increasing whereas $\lambda^*(r, \tau)$ is increasing in τ.

Case 3: $P_1 = D$. We know platform P_1 always sets $r = \bar{r}$ as it maximizes the reservation value, regardless of the choices of Platform 2. Proposition 3 then implies $P_2 = D$ is always dominated by $P_2 = H$. Then, If $P_2 = M$, we have

$$\Pi_{2,DM} = G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{DM}))\right) \tau_{DM} v(\lambda^*(\bar{r}, \tau_{DM}))$$

If $P_2 = H$, we have

$$\Pi_{2,DH} = G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{DH}))\right) \left(\frac{A}{2} + \tau_{DH} v(\lambda^*(\bar{r}, \tau_{DH}))\right) - C.$$

If $\Pi_{2,DH} > \Pi_{2,DM}$ for all $A \geq 0$, then let $A_{MH} = 0$. Otherwise, let A_{MH} be the solution to $\Pi_{2,DH} = \Pi_{2,DM}$, which exists and is unique given $\Pi_{2,DH}$ is strictly increasing in A by the envelope theorem.[32] Then, $\Pi_{2,DH} \geq \Pi_{2,DM}$ if and only if $A \geq A_{MH}$.

[32] Note that we can use the envelope theorem here because Platform 1 has a dominant strategy in the competitive subgame where it operates as a pure discovery platform and therefore platform 2's maximization problem does not have to account for a competitive response to its change of strategy.

Finally, observe that for all $A < A'_{MH}$ as defined in (B.7), we have

$$\begin{aligned}\Pi_{2,DH} &< G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{DH}))\right)\left(\frac{A'_{MH}}{2}+\tau_{DH}v(\lambda^*(\bar{r},\tau_{DH}))\right)-C \\ &= G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{DH}))\right)\tau_{2,DH}v(\lambda^*(\bar{r},\tau_{DH})) \\ &\leq \max_{\tau\in[0,1]}\left\{G\left(\tilde{u}(\lambda^*(\bar{r},\tau))\right)\tau v(\lambda^*(\bar{r},\tau))\right\}=\Pi_{2,DM}\end{aligned}$$

where we invoked symmetry $\tau_{DH} = \tau_{HD}$ in the second equality. Thus, $A < A'_{MH}$ implies $A < A_{MH}$, hence we conclude $A'_{MH} \leq A_{MH}$. Finally, from the definitions of A'_{MH} and A_{MH}, it is clear that both are increasing in C and equal zero when $C = 0$.

We are now ready to prove Proposition 5. When $A < A_{MH}$, Proposition 4 implies that $P_l = M$ and $P_{-l} = D$ are the unique best responses to each other for $l = 1, 2$. When $A \geq A_{MH} \geq A'_{MH}$, Proposition 4 implies that $P_l = H$ and $P_{-l} = D$ are the unique best responses to each other. ■

Proof. (**Corollary 2**). For any $r \geq 0$, denote

$$\hat{\tau}(r, A) \equiv \arg\max_{\tau} G\left(\tilde{u}(\lambda^*(r,\tau))\right)\left(A + \tau v(\lambda^*(r,\tau))\right) \quad \text{for any given } r \geq 0.$$

which is the same expression as (B.1). Given assumption $s > \bar{s}_{max}$, we know from Claim 1 and the proof of Proposition 2 that $\lambda^*(r, \hat{\tau}(r, A)))$ is weakly increasing in r and A.

Consider $A \leq A_{mono}$ so that the monopolist operates in pure membership and the equilibrium design is $\lambda^*_M = \lambda^*(-\infty, \hat{\tau}(0, -\infty))$. With competition, if $(P_l, P_{-l}) = (D, H)$, then the equilibrium design is $\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, A/2)) \geq \lambda^*(-\infty, \hat{\tau}(-\infty, 0))$; if $(P_l, P_{-l}) = (D, M)$, then the equilibrium design is $\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, 0)) \geq \lambda^*(-\infty, \hat{\tau}(-\infty, 0))$.

Consider $A > A_{mono}$ so that the monopolist operates in hybrid and the equilibrium design is $\lambda^*_H = \lambda^*(r^*_H, \hat{\tau}(r^*_H, A))$. With competition, suppose $(P_l, P_{-l}) = (D, H)$: if $\bar{r} \to \infty$ then

$$\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, A/2)) \to 1 \geq \lambda^*(r^*_H, \hat{\tau}(r^*_H, A));$$

and if $\bar{r} \to \underline{r}$ then $\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, 0)) \to \lambda^*(\underline{r}, \hat{\tau}(\underline{r}, A/2)) \leq \lambda^*(\underline{r}, \hat{\tau}(\underline{r}, A)) = \lim_{\bar{r}\to\underline{r}} \lambda^*_H$. Suppose $(P_l, P_{-l}) = (D, M)$: if $\bar{r} \to \infty$ then

$$\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, 0)) \to 1 \geq \lambda^*(r^*_H, \hat{\tau}(r^*_H, A));$$

and if $\bar{r} \to \underline{r}$ then $\lambda^*(\bar{r}, \hat{\tau}(\bar{r}, 0)) \to \lambda^*(\underline{r}, \hat{\tau}(\underline{r}, 0)) \leq \lambda^*(\underline{r}, \hat{\tau}(\underline{r}, A)) = \lim_{\bar{r}\to\underline{r}} \lambda^*_M$. ■

Proof. **(Proposition 6).** For any given business model choices (P_l, P_{-l}) and choice variables chosen by the platforms, the analysis of the consumer-creator subgame is analogous to Lemma 2:

1. Let $r_{\max} = \max\{r_1, r_2\}$, and let $\tau_{mean} = \frac{\tau_1}{2} + \frac{\tau_2}{2}$ if there are two membership portals and $\tau_{mean} = \tau_l$ if only a single platform l operates a membership portal. The equilibrium of the consumer-creator subgame is:

   (a) Each creator i joins all discovery portal(s) and membership portal(s). Then, the creator sets design λ^* that solves

$$\lambda^* = \arg\max_{\lambda_i \in [0,1]} \left\{ D\left(\frac{\tilde{u}(\lambda_i)}{1 - r_{\max}}; \frac{\tilde{u}(\lambda^*)}{1 - r_{\max}} \right) (a + (1 - \tau_{mean}) v(\lambda_i)) \lambda_i \right\} \tag{B.8}$$

   where the search reservation value $\tilde{u}(\lambda_i)$ is given by (7).

   (b) Consumers join all discovery portal(s) but split their participation evenly across the membership portals available. Believing that all creators adopt strategy λ^*, a consumer initiates search if and only if $x \leq \tilde{u}(\lambda^*)$ and does so through the discovery portal with the highest r_l (and follows the recommendation for every search). The mass of consumers who search is $G(\tilde{u}(\lambda^*))$.

   (c) Upon finding a positive match value creator, a consumer stops searching and becomes a viewer of the creator. The consumer use membership portal that she has joined to carry out transactions (if any).

In the following, $\lambda^* = \lambda^*(r, \tau)$ is given by (B.8. Note that assumption $s > \bar{s}_{max}$ and Proposition 1 together imply $\lambda^*(r, \tau)$ is increasing in τ and r. We let platform indices $l = 2$ and $-l = 1$ without loss of generality. We first show $P_2 = D$ is always dominated by $P_2 = H$. This is obvious if $P_1 = D$ (by Proposition 3). Consider $P_1 = M$, and we want to show $\Pi^*_{2,MH} \geq \Pi^*_{2,MD}$. Let $(\tau_{1,MH}, \tau_{2,MH})$ and r_{MH} denote platforms' equilibrium commissions and sensitivity when $(P_1, P_2) = (M, H)$, and denote

$$\tau_{mean} \equiv \frac{\tau_{1,MH} + \tau_{2,MH}}{2}$$

Let τ_{MD} and $r_{MD} = \bar{r}$ be the counterparts when $(P_1, P_2) = (M, D)$. We first prove the following claim:

Claim. a necessary condition for $\tau_{mean} < \tau_{MD}$ is $r_{MH} < \bar{r}$. To prove this, recall $\tau_{MD} > 0$ (chosen by Platform 1 whose $P_1 = M$, taking as given $\bar{r}$ by Platform 2 whose $P_2 = D$) is given by $\tau_{MD} = \hat{\tau}(\bar{r})$, where

$$\hat{\tau}(r) \equiv \arg\max_{\tau} G(\tilde{u}(\lambda^*(r, \tau)))(A + \tau v(\lambda^*(r, \tau))) \quad \text{for any given } r \geq 0$$

satisfies FOC

$$1 + \hat{\tau} \frac{d\lambda^*}{d\tau} \underbrace{\left(\frac{g(\tilde{u}(\lambda^*(r, \hat{\tau})))}{G(\tilde{u}(\lambda^*(r, \hat{\tau})))} \frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*(r, \hat{\tau}))}{v(\lambda^*(r, \hat{\tau}))} \right)}_{<0} = 0. \tag{B.9}$$

Meanwhile, $\tau_{1,MH} > 0$ (chosen by Platform 1 whose $P_1 = M$) and $\tau_{2,MH} > 0$ (chosen by Platform 2 whose

$P_2 = H$) jointly satisfy

$$1 + \frac{\tau_1}{2}\frac{d\lambda^*}{d\tau}\left(\frac{g\left(\tilde{u}(\lambda^*)\right)}{G\left(\tilde{u}(\lambda^*)\right)}\frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*)}{v(\lambda^*)}\right) = 0 \tag{B.10}$$

$$1 + \frac{\tau_2}{2}\frac{d\lambda^*}{d\tau}\left(\frac{g\left(\tilde{u}(\lambda^*)\right)}{G\left(\tilde{u}(\lambda^*)\right)}\left(\frac{2A}{\tau_2 v(\lambda^*)}+1\right)\frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*)}{v(\lambda^*)}\right) = 0 \tag{B.11}$$

where $\lambda = \lambda^*(r_{MH}, \tau_{mean})$. Given $A \geq 0$ in (B.11), it means

$$1 + \frac{\tau_2}{2}\frac{d\lambda^*}{d\tau}\left(\frac{g\left(\tilde{u}(\lambda^*)\right)}{G\left(\tilde{u}(\lambda^*)\right)}\frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*)}{v(\lambda^*)}\right) < 0.$$

Summing up the inequality above with (B.10), we get (after making $\lambda^* = \lambda^*(r_{MH}, \tau_{mean})$ explicit):

$$\tau_{mean}\frac{d\lambda^*}{d\tau}\left(\frac{g\left(\tilde{u}(\lambda^*(r_{MH},\tau_{mean}))\right)}{G\left(\tilde{u}(\lambda^*(r_{MH},\tau_{mean}))\right)}\frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*(r_{MH},\tau_{mean}))}{v(\lambda^*(r_{MH},\tau_{mean}))}\right) < -2. \tag{B.12}$$

Observe that if $r_{MH} = \bar{r}$, then (B.12) and (B.9) together yields $\tau_{mean} \geq \hat{\tau}(r_{MH}) = \hat{\tau}(\bar{r}) = \tau_{MD}$ because evaluating the LHS of (B.9) at $\tau = \tau_{mean}$ would yield a value that is bounded above by $1 - 2 < 0$. This proves the claimed necessity of $r_{MH} < \bar{r}$

To establish $\Pi^*_{2,MH} \geq \Pi^*_{2,MD}$, we consider two separate cases. First, suppose $\tau_{mean} \geq \tau_{MD}$, then

$$\begin{aligned}
\Pi^*_{2,MH} &= G\left(\tilde{u}(\lambda^*(r_{MH},\tau_{mean}))\right)\left(A + \tau_{2,MH} v(\lambda^*(r_{MH},\tau_{mean}))\right) - C \\
&\geq G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{mean}))\right)\left(A + \tau_{2,MH} v(\lambda^*(\bar{r},\tau_{mean}))\right) - C \\
&\geq G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{mean}))\right) A - C \\
&\geq G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{MD}))\right) A - C = \Pi^*_{2,MD},
\end{aligned}$$

where the first inequality is due to the definition of r_{MH} being an optimizer (with platform 2 operating the sole discovery portal); the second inequality is due to $\tau_{2,MH} \geq 0$; the last inequality is due to $\tau_{mean} \geq \tau_{MD}$. Second, suppose $\tau_{mean} < \tau_{MD}$, which implies $r_{MH} < \bar{r}$ by the necessity claim proven above. Then,

$$\begin{aligned}
\Pi^*_{2,MH} &= G\left(\tilde{u}(\lambda^*(r_{MH},\tau_{mean}))\right)\left(A + \tau_{2,MH} v(\lambda^*(r_{MH},\tau_{mean}))\right) - C \\
&\geq G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{MD}))\right)\left(A + \tau_{2,MH} v(\lambda^*(\bar{r},\tau_{MD}))\right) - C \\
&> G\left(\tilde{u}(\lambda^*(\bar{r},\tau_{MD}))\right) A - C = \Pi^*_{2,MD}
\end{aligned}$$

where the first inequality is due to a revealed preference argument (from $r_{MH} < \bar{r}$) that implies $G\left(\tilde{u}(\lambda)\right)\left(A + \tau_{2,MH} v(\lambda)\right)$ is decreasing in λ for all $\lambda \geq \lambda^*(r_{MH}, \tau_{mean})$ and that $\lambda^*(\bar{r}, \tau_{MD}) > \lambda^*(r_{MH}, \tau_{mean})$; the second inequality is due to $\tau_{2,MH} > 0$.

Finally, consider $P_1 = H$ and we will again show $\Pi^*_{2,HH} > \Pi^*_{2,HD}$. To that end, we first show $\tau_{HH} \geq \tau_{HD}$. Recall the FOC for $\tau_{HD} > 0$ (chosen by Platform 1 whose $P_1 = H$, taking as given $\bar{r}$ by

Platform 2 whose $P_2 = D$):

$$1 + \tau_{HD} \frac{d\lambda^*}{d\tau} \left(\frac{g\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD}))\right)}{G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD}))\right)} \left(\frac{A/2}{\tau_{HD} v(\lambda^*(\bar{r}, \tau_{HD}))} + 1 \right) \frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*(\bar{r}, \tau_{HD}))}{v(\lambda^*(\bar{r}, \tau_{HD}))} \right) = 0$$

whereas $\tau_{HH} > 0$ has FOC:

$$2 + \tau_{HH} \frac{d\lambda^*}{d\tau} \left(\frac{g\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HH}))\right)}{G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HH}))\right)} \left(\frac{A}{\tau_{HH} v(\lambda^*(\bar{r}, \tau_{HH}))} + 1 \right) \frac{\partial \tilde{u}}{\partial \lambda_i} + \frac{v'(\lambda^*(\bar{r}, \tau_{HH}))}{v(\lambda^*(\bar{r}, \tau_{HH}))} \right) = 0$$

Again, comparing the two FOCs as above shows $\tau_{HH} \geq \tau_{HD}$. Returning to Platform 2's profit:

$$\begin{aligned} \Pi^*_{2,HH} &= G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HH}))\right) \left(\frac{A}{2} + \frac{\tau_{HH}}{2} v(\lambda^*(\bar{r}, \tau_{HH})) \right) - C \\ &> G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HH}))\right) \frac{A}{2} - C \\ &\geq G\left(\tilde{u}(\lambda^*(\bar{r}, \tau_{HD}))\right) \frac{A}{2} - C = \Pi^*_{2,HD}, \end{aligned}$$

as required.

After ruling out optimality of platform 2 choosing $P_2 = D$, it remains to compare Π^*_{2,P_1H} and Π^*_{2,P_1M} for each $P_1 \in \{M, D, H\}$. Applying the envelope theorem to the comparative statics with respect to A, it is easily verified $\Pi^*_{2,P_1H} - \Pi^*_{2,P_1M}$ is monotone increasing in A, thus proving the proposition statement. ■

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