Fending off Critics of Platform Power: Doing Well by Doing Good?

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Abstract

Many digital platforms have accrued enormous power and scale, leveraging cross-side network effects between the sides they connect (e.g., producers and consumers; or creators and viewers). Platforms motivate a diverse spectrum of producers, large and small, to participate by sharing platform revenue with them, predominantly under a linear revenue-sharing scheme with the same commission rate regardless of producer power or size. Under pressure from society, lawsuits, and antitrust investigations, major platforms have announced revenue sharing designs that favor smaller businesses. We develop a model of platform economics, and show that a small-business oriented (SBO) differential revenue sharing design can increase total welfare and outputs on the platform. While the small producers almost always benefit from the shift in revenue sharing design, large producers can also be better off under some conditions. More interestingly, we show that platforms are the most likely winner under a differential revenue sharing scheme. Hence, an intervention that ostensibly offers concessions and generous treatment to producers might well be self-serving for platforms and also good for the entire ecosystem.

Keywords: Platform, revenue-sharing, platform regulation, ecosystem design

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1 Introduction

Tech giants such as Amazon, Apple, Facebook, Google, software platforms such as Atlassian and Auth0, and many other e-commerce sites, offer third-party sellers (or, creators, developers, producers) a platform on which they can create and sell individual products, including both digital content and physical goods (Cusumano et al., 2019). These products enhance the platform's customer traffic and demand, enabling it to generate revenue either via a transaction marketplace (e.g., App Store, Play Store, or Amazon.com) or through advertising (e.g., YouTube, Tik Tok or Facebook). Although these platforms are diverse in type and industry they operate in, they have a common approach to revenue sharing[1]: for each dollar of sales, the platform returns a share or commission γ to the producer and keeps a "tax" rate $(1-\gamma)$, with a single rate for all producers regardless of their scale or segment. This approach has dominated for decades since iTunes' revenue sharing formula for mp3s, and previously the royalty fees charged by gaming consoles to game developers. In a recent interview,[2] the Snapchat CEO Evan Spiegel acknowledged the value that the platform provides, noting that "We're happy to pay Apple 30%" in exchange for enabling hardware, software infrastructure, and marketing reach.

The network effects inherent in multi-sided marketplaces create a strong force towards winner-take-all outcomes. The consequent massive scale, profit, market capitalization, and influence, achieved by a few platforms has caused a backlash against them. Judiciary Committee Chairman Jerrold Nadler (D-N.Y.) and antitrust subcommittee Chairman David Cicilline (D-R.I.) said in a joint statement that "As they exist today, Apple, Amazon, Google, and Facebook each possess

[1] https://www.theverge.com/21445923/platform-fees-apps-games-business-marketplace-apple-google

[2] https://www.cnbc.com/2021/05/21/snap-ceo-evan-spiegel-were-happy-to-pay-apple-30percent.html

significant market power over large swaths of our economy. In recent years, each company has expanded and exploited their power of the marketplace in anti-competitive ways".[3] These platforms have been attacked on many fronts, and are presently fighting off antitrust lawsuits in many parts of the world. One of the key issues many developers and creators protest and take legal action against is the platforms' commission levels. Consequently, powerful platforms are under increasing pressure to start tweaking their long-standing single-rate revenue-sharing scheme. Indeed, they have begun doing so. Apple, Google and Amazon have slashed fees for smaller business units. Apple launched the "App Store Small Business Program" in January 2021, reducing its standard 30% fee for in app purchases to 15% for smaller businesses with App Store below $1 million.[4] Similarly, Google announced in March 2021 that developers on Google Play will be charged a lowered service fee of 15% (down from the original 30%) for their first $1 million in sales through the Google Play billing system.[5]

In a static view of platform economics, such a *small-business oriented* (SBO) restructuring of the revenue sharing system may be perceived as a revenue loss for the platform. And because of its direct relevance to the producers in the ecosystem, SBO revenue restructuring has, with some success, become the first line of defense against antitrust pressures. In this paper, we ask several questions motivated by the fact that the platform ecosystem is *not* static: does a SBO restructuring expand the ecosystem by creating economic viability for more (smaller) producers? How does it change the output of producers who were below, or above, the threshold? Do those changes cause a spillover effect on platform revenue? And overall, how does this restructuring affect producer profits and, ultimately, does it necessarily mean a profit sacrifice to the platform? These questions provide an avenue for both academics and policy makers to examine the effectiveness of these

[3] `https://arstechnica.com/tech-policy/2020/10/house-amazon-facebook-apple-google-have-monopoly-power-should-be-split/`

[4] `https://techcrunch.com/2020/11/18/apple-to-reduce-app-store-fees-for-small-businesses-with-under-1-million-in-revenues/`

[5] `https://techcrunch.com/2021/03/16/google-play-drops-commissions-to-15-from-30-following-apples-move-last-year/`

restructurings with regard to multiple objectives.

The analysis in this paper offers a counterpoint to the booming current debate on how to curtail the dominance or power of platforms. Current proposals discriminate in favor of (or at least intend to) one side at the cost of the other. For instance, calls for regulating platforms seek to reduce platform payoffs while increasing (only possibly, in our view) the surplus of other parties. Our analysis demonstrates that making producers better off need not necessarily hurt the platform. There exist solutions which improve overall economic outcomes and, in the best case, are *Pareto improving*. This is not surprising: the practice of platform economics is—despite their huge success—not yet fully optimized. This creates room for platforms to take actions, such as nonlinear pricing, that increase their own payoff while also improving the aggregate economic outcomes for other platform participants. Consistent with the improved power of versioning under network effects (Bhargava and Choudhary, 2004), the positive spillovers caused by cross-side network effects are crucial in causing win-win-win outcomes in some cases. Our results are both hopeful and constructive with regard to designing platform ecosystems that better serve all parties.

For policy makers, our analysis demonstrates a plausible mechanism under which a SBO revenue sharing structure can lead to welfare gain for both producers and platform. It also suggests that although the SBO revenue sharing scheme does not directly punish the large producers, they often bear the cost of subsidizing small producers (instead of the platform) due to naturally occurring competition amongst producers. And lastly, our analysis suggests that the platforms often directly gain from this type of SBO scheme despite their apparent generosity in returning more revenue to producers. These results are instrumental in evaluating the social value resulting from such revenue restructuring set forth by the platforms.

Existing research on revenue-sharing in platforms—on issues such as information asymmetry between the platform and creators (Bart et al., 2020), the nature of bargaining between the platform and producers (MacDonald and Ryall, 2004; Oh et al., 2015), and how platforms can gradually squeeze the surplus retained by producers (Balseiro et al., 2017)—has been set under a single commission rate. Bhargava (2022) underlines the limitations and misalignment caused by a single rate applied to heterogeneous producers. To our knowledge, ours is the first paper to examine alternatives to a single commission rate scheme, and specifically the implications of differential revenue sharing. Differential designs have been explored for consumer heterogeneity, including nonlinear pricing under interdependent demand or network effects (Oren et al., 1982), but differential revenue-sharing makes a crucial departure due to the production externality and cross-side network effects feedback loop where producers compete for consumers yet benefit from the increased consumer traffic brought by their competitors' output. An SBO scheme is novel and distinctive in an additional crucial regard. Traditional solutions for heterogeneity such as nonlinear pricing give extra surplus to high-type participants (an "information rent" to prevent them from mimicking low types) while squeezing out the surplus from low-type participants (Maskin and Riley, 1984). An SBO scheme does the opposite, hence it is notable that it still improves the principal's (platform's) payoff and that it remains most impactful when there's greater heterogeneity among producers.

2 Modeling Framework

This section specifies our model of the economic interactions between a platform and producers in the ecosystem. Given our goals of understanding how the revenue-sharing scheme impacts ecosystem participation and engagement by producers, and consequently platform scale, revenues and profit, we employ a modeling apparatus based on two recent papers on platform scale (Bhargava, 2021; Bhargava, 2022).

2.1 Ecosystem Structure and Interactions

Consider a platform (principal) that facilitates a potentially vast army of third-party producers to offer their goods to platform users. Producer j's output Q_j measures its contribution toward platform revenues or transactions with users. This parameter can be interpreted in numerous ways, such as the quantity of in-app features created, or the quality of posts created by a social media influencer. Producers are heterogeneous in their ability to engage on the platform, some are better endowed than others in terms of production capabilities, talent, intellectual property, or other advantages. Producer heterogeneity is captured via an index of parameters c_j, representing the cost that producer j would incur to make unit output, absent competition from any other producers. Without loss of generality, assume that the producer-index is defined such that the c_j's are in ascending order, so that c_1 is considered the most powerful or efficient producer. For instance, some YouTubers are better at making more and better quality videos than others, and the cost parameter c_j thus reflects this ability.

The platform's scale is $Q = \sum_j Q_j$. The platform monetizes the producer-user interactions around these goods in some way, such as a subscription fee (e.g., Pandora), advertising (e.g., Tik Tok), or individual trades (e.g., iOS App Store). We abstract out the details by employing a generic monetization model, wherein the surplus created by the platform has the functional form $R(Q) = \beta Q^\theta$, where $\theta \in [0, 1]$ captures curvature of the demand function and $\beta > 0$ is a constant multiplier. The platform returns a fraction γ of this revenue to producers. Producer j's compensation is $\gamma \frac{Q_j}{Q} \beta Q^\theta$, reflecting its own share $\frac{Q_j}{Q}$ of total revenue $R(Q)$. Figure 1 depicts the described relationship between output Q_j, revenue $R(Q)$ and j's payoff.

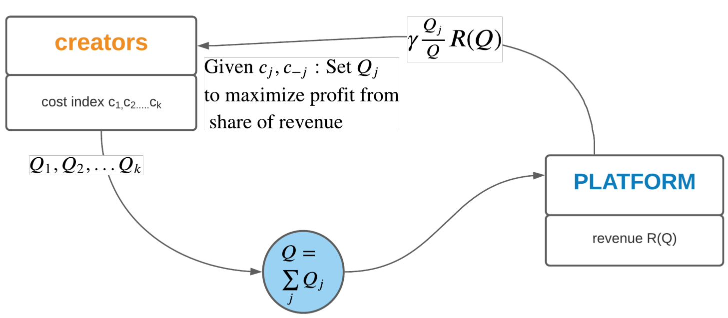


Figure 1: Economic interaction between platform and creators

This structure captures several features of the industry. It reflects diminishing marginal returns in platform revenue from increased contribution by producers, generalizing the two different monetization-models employed in (Bhargava, 2021; Bhargava, 2022).[6] It captures production externalities, where increased output from any producer increases overall platform demand, as demonstrated in Haviv et al. (2020).[7] This feature reflects the notion that consumers' time and resources are finite but elastic. This model also captures competition between producers, implying that for each producer, higher output by other producers reduces the focal producer's proportional share $\frac{Q_j}{Q}$ of platform sales (Bhargava, 2021).[8] The order of play is that the platform first determines the way total payoff is shared between the producer and the platform, then the producers choose their payoff-maximizing output levels Q_j.

Our goal of analyzing differential revenue-sharing scheme can be studied with respect to the minimal such scheme, one that has just two revenue-sharing rates; and a minimal producer ecosystem in which there are potentially just two types of producers: 1) efficient or "bigger" producers with the lower cost index c_1, and 2) less efficient producers with the higher cost index c_2. Normalizing the size of the first type to be 1, let N be the number of type-2 producers for every type 1 producer, so that $Q = Q_1 + NQ_2$. This setup serves the primary requirement of differentiating between the more versus less capable producers, or (endogenously) the larger and smaller businesses on a platform. In practice, a few large businesses generate a large fraction of the sales on a platform. For instance, between January and October 2020, 96.7% of all gaming apps on the Apple App Store had sales under 1 million, but their combined sales only covered 2% of all gaming

[6] As an example of underlying micro-foundations of this platform model with cross-side network effects on both sides, suppose that the platform attracts demand $AQ^{\phi} - bP$ on its consumer side (with $\phi < 1$) when it brings in product value units Q from its producer side and charges a normalized price P per value unit. Then (with zero variable costs, hence setting $P^* = \frac{AQ^{\phi}}{2b}$), the net surplus under scale Q is $\frac{A^2 Q^{2\phi}}{4b}$, which fits $\beta = \frac{A^2}{4b}$ and $\theta = 2\phi$. This surplus, from which producers get a revenue share, is increasing when consumer demand is stronger (higher A or ϕ), hence producers' motivation to join and engage with the platform is stronger when the platform has more consumers.

[7] Production externality can be understood as a result of consumers' overall budgeting decisions. For instance, when Netflix produces more and better videos, (more) consumers spend more time watching television instead of going out to bars.

[8] In our model, one can see that when both production externality and producer competition are in place, one producer increases its output leads to a decrease in all other producers' payoffs, when all other producers hold their output levels constant.

revenue. Conversely, only 2.7% of game publishers generate revenues of 1.5 million or more.[9]

2.2 Benchmark: Performance-based Compensation with a Single Rate

In the benchmark design, the platform returns a common share γ of its total payoff to the producer, leading to the profit functions below.

$$\Pi_p = (1-\gamma)\beta Q^{\theta} \quad \text{profit of platform, where } \; Q = Q_1 + NQ_2 \tag{1}$$

$$\pi_j = \gamma \frac{Q_j}{Q} \beta Q^{\theta} - c_j Q_j \quad \text{profit of producer } j. \tag{2}$$

Lemma 1 specifies the producer sub-game equilibrium in this setting with a revenue-sharing rate γ, and the rate that maximizes the platform's profit.

Lemma 1 (Platform and Producer Equilibrium)**.** *The single-rate equilibrium in a platform which generates surplus βQ^{θ} with two producers types $j{=}1,2$ in ratio $1{:}N$ with cost indices (c_1, c_2), is*

$$Q_j^* = \left[1 - c_j\left(\frac{N+\theta}{c_1 + Nc_2}\right)\right] \frac{Q^*}{(1-\theta)} \tag{3a}$$

$$\textit{with} \quad Q^* = Q_1 + NQ_2 = \begin{cases} \left(\frac{\beta\gamma\theta}{c_1}\right)^{\frac{1}{1-\theta}} & \textit{if } c_2 \geq \frac{c_1}{\theta} \\ \left(\frac{\beta\gamma(N+\theta)}{c_1+Nc_2}\right)^{\frac{1}{1-\theta}} & \textit{if } c_2 < \frac{c_1}{\theta} \end{cases} \tag{3b}$$

$$\Pi^* = (1-\gamma)\beta\left[\gamma\beta\left(\frac{N+\theta}{c_1+Nc_2}\right)\right]^{\theta/(1-\theta)}. \tag{3c}$$

when $c_2 < \frac{c_1}{\theta}$. The platform generates revenue $\beta\left[\gamma\beta\left(\frac{N+\theta}{c_1+Nc_2}\right)\right]^{\theta/(1-\theta)}$ of which it retains a share $(1-\gamma)$. The platform maximizes revenue by setting revenue-share parameter $\gamma^* = \theta$. When $c_2 \geq \frac{c_1}{\theta}$, then $Q_2 = 0$ and only the more efficient producer is viable.

[9] `https://sensortower.com/blog/app-store-revenue-share-analysis`

3 Differential Revenue Sharing

The single γ design embeds substantial imbalance *within* the producer ecosystem. Smaller producers with high c_j's are not only disadvantaged because they engage in a "competition for eyeballs" with other producers who have lower c_j, but the marginal revenue that they receive (which affects how much they should produce) is progressively reduced as other producers add more output-units into Q, due to concavity in the platform's revenue function. This implies higher market concentration in the producer ecosystem (e.g., for $N{=}1$, $\frac{Q_1}{Q_2} > \frac{c_2}{c_1}$, evident from Eq. 3a). Neither is this outcome ideal for the platform, because most platforms seek a vibrant and broad ecosystem of producers. In response to concerns from both producers and policy-makers, platforms have begun experimenting with differential revenue sharing, supplementing the standard revenue-share γ with a higher level of revenue-share η upto some level of revenue contribution S.

3.1 Formulation and Problem Reduction

Now consider a differential revenue sharing arrangement where the platform returns share $\eta > \gamma$ for revenue-contributions upto threshold S and a lower rate γ for residual contributions.[10] Thus, producers with revenue below S receive $\eta\frac{Q_j}{Q}\beta Q^{\theta}$, while those above S receive $\eta S{+}\gamma(\frac{Q_j}{Q}\beta Q^{\theta}{-}S)$. Denote the equilibrium values of producer output under the two-rate scheme as $\tilde{Q}_i$. We retain the notation (Q_1, Q_2) when referring to the terms generally.

Lemma 2 (Equilibrium Space Truncation)**.** *The threshold contribution level S to receive the favorable rate η satisfies $S{=}\frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ (and, hence, $S{<}\frac{\tilde{Q}_1}{\tilde{Q}}R(\tilde{Q})$), where $(\tilde{Q}_1, \tilde{Q}_2)$ are the equilibrium output levels under the (η, S) adjustment to the (optimal) single-rate γ scheme. Further, $\eta \leq \frac{c_2\gamma}{c_1}$.*

Lemma 2 eliminates (η, S) combinations that, trivially, are (for the platform) dominated by other combinations. Although we seek to demonstrate *plausibility* of certain economic conse-

[10]There are multiple variations of SBO revenue sharing in practice. The one we use in this paper matches Google's approach. Another alternative is where small businesses earning up to a threshold S get a better share η, and larger business earning over the threshold S get the lower share γ for their *entire* revenue - this is similar to what Apple has recently announced. This alternative achieves the same subgame perfect equilibrium output from the producers, and preserves key results including the win-win-win potential of the SBO scheme.

quences of differential revenue-sharing (hence not requiring the *optimal* design), elimination of these unattractive designs simplifies the analysis of the scheme. The truncation ensures that an *SBO* differential revenue sharing equilibrium, if it exists, rewards the small high-cost producers with a favorable rate for their entire output. Intuitively, this truncation works by ruling out i) $S{>}\frac{\tilde{Q}_1}{\tilde{Q}}R(\tilde{Q})$ which would imply a single non-optimal rate η that is applied to everyone, ii) $S{<}\frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ which makes the η rate irrelevant in terms of changing the output levels, and iii) $S{>}\frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ which gives producer 1 a higher rate η up to an unnecessarily high level without ultimately impacting his output level. With this result, the differential revenue-sharing design can be thought of as picking a rate $\eta > \gamma$ (but less than $\frac{c_2\gamma}{c_1}$), then fixing S to the appropriate equilibrium level, and then possibly optimizing on η with respect to a suitable objective (e.g., platform's profit, or some properties of the producer ecosystem, etc.). This truncation also enables solving the differential revenue sharing problem by transforming it into the well-understood single-rate revenue sharing problem, as shown next.

Theorem 1 (Problem Equivalence)**.** *The producer-subgame when producers have cost indices $\frac{c_j}{\gamma}$ and the platform returns 100% of revenue to producers, is identical to the one stated in Lemma 1 (with cost indices c_j and a revenue share parameter γ) and yields the same equilibrium outcome as in Eq. 3.*

3.2 Differential Rate Equilibrium

Under the differential revenue sharing scheme described above, the total revenue generated on the platform is $R(Q){=}\beta Q^{\theta}$, of which the surplus available to producer types 1,2 (π_1, π_2) and the platform's own share Π, depend on whether each producer's output exceeds or is below S.

Applying Lemma 2 this condition is resolved as below.

$$\pi_1 = \left(\eta S + \gamma\left(\frac{Q_1}{Q}\beta Q^\theta - S\right)^+ - c_1 Q_1\right) = \left((\eta-\gamma)S + \gamma\frac{Q_1}{Q}\beta Q^\theta - c_1 Q_1\right) \tag{4a}$$

$$\pi_2 = \left(\eta S + \gamma\left(\frac{Q_2}{Q}\beta Q^\theta - S\right)^+ - c_2 Q_2\right) = \eta S - c_2 Q_2 \tag{4b}$$

$$\Pi = \beta Q^\theta - (\eta-\gamma)S - \beta Q^{\theta-1}(\gamma Q_1 + N\eta Q_2) \tag{4c}$$

The differential revenue-sharing arrangement creates a non-linear (i.e., piecewise-linear) payoff function for some producers (here, producer 1 in the 2-type case), implying a simultaneous game with non-differentiable payoff functions. However, the combination of Theorem 1 and Lemma 2, by ensuring that only the region $c_1 \leq c_2\gamma/\eta$ is relevant, enables computation of this more complex problem using the solution apparatus of Lemma 1. [11]

Theorem 2 characterize equilibrium solutions under the SOB differential rate design:

Theorem 2 (Differential-Rate Equilibrium)**.** *The differential-rate equilibrium with $\eta > \gamma$ is identical to the single-rate equilibrium for producer cost indices $\hat{\chi} = (c_1, c_2\gamma/\eta)$ and which transfers γ share of revenue to producers and returns an extra payoff $(\eta-\gamma) * S$ to producer 1. Hence, both producers are viable when $c_2 < \frac{c_1\eta/\gamma}{\theta}$, yielding*

$$\tilde{Q} = \left(\frac{\gamma\beta(N+\theta)}{c_1 + Nc_2\gamma/\eta}\right)^{\frac{1}{1-\theta}} \tag{5a}$$

$$\tilde{Q}_1 = \left(1 - \frac{c_1(N+\theta)}{c_1 + Nc_2\gamma/\eta}\right)\frac{\tilde{Q}}{1-\theta} \tag{5b}$$

$$\tilde{Q}_2 = \left(1 - \frac{(N+\theta)c_2\gamma/\eta}{c_1 + Nc_2\gamma/\eta}\right)\frac{\tilde{Q}}{1-\theta} \tag{5c}$$

$$\tilde{S} = \frac{\beta}{1-\theta}\left(1 - \frac{(N+\theta)c_2\gamma/\eta}{c_1 + Nc_2\gamma/\eta}\right)\left(\frac{\gamma\beta(N+\theta)}{c_1 + Nc_2\gamma/\eta}\right)^{\frac{\theta}{1-\theta}} \tag{5d}$$

$$\tilde{\Pi} = \beta\tilde{Q}^\theta(1-\gamma) - (\eta-\gamma)(1+N)\tilde{S} \tag{5e}$$

[11] Trivially, a differential design which leaves type-2 producers unviable is meaningless, hence is ignored in the analysis.

	Q_1	Q_2	Q	π_1	π_2	Π
single	101.6	0	101.6	1524	0	3810
differential	117.7	15.92	133.6	1530	39.24	3829

Table 1: An example of a win-win-win outcome (parameter values were $\theta{=}0.4{=}\gamma, \beta{=}1000, c_1{=}10, c_2{=}32, N{=}1, \eta{=}0.65$), in which switching to an SBO differential rate increases ecosystem participation, with 1) entry and (higher) output by smaller producers, 2) higher output and profit for large producer, and 3) higher profit for platform.

4 Economic Consequences of Differential Revenue Sharing

In this section, we examine how a small-business-oriented (SBO) differential revenue sharing design affects output, profit, and welfare, compared against the benchmark single rate design. We also discuss how the distribution of producer-characteristics in the ecosystem influences the effectiveness of the differential payment design. We compared the closed-form solutions for the output levels and profits in the differential-rate and single-rate schemes. Propositions 1-3 are derived analytically, while other insights are obtained by evaluating a battery of problem instances across a parameter space Λ defined as a cross-product of ($\theta \in [0.1, 0.75], \eta \in (\gamma, 0.8), N \in [1, 20], c2 \in [11, 800)$), normalizing c_1 to 10, and setting $\beta = 1000$ since it is a scaling parameter, and filtering out tuples to enforce Lemma 2 and to ensure economic viability of producer-type 2 in the differential-rate case (Theorem 2), while also avoiding extreme values (e.g., near boundaries for restricted variables) that lead to unbounded solutions or trivial insights. For each parameter, sampled values represent a uniform distribution within the interval for that parameter.

Intuitively, the SBO scheme creates the following forces as it increases participation and output of type-2 (smaller) producers: it alters output of type 1 producer (higher, if spillover effects dominate; lower, if competition effect dominates) and thereby total output Q; this in turn impacts overall consumer traffic to platform and the revenue that generates; and the altered revenue potential has an additional effect on output choices of producers. In this section we dig deeper into and formalize the above intuitions about the multiple forces at play. Specifically, we show conditions

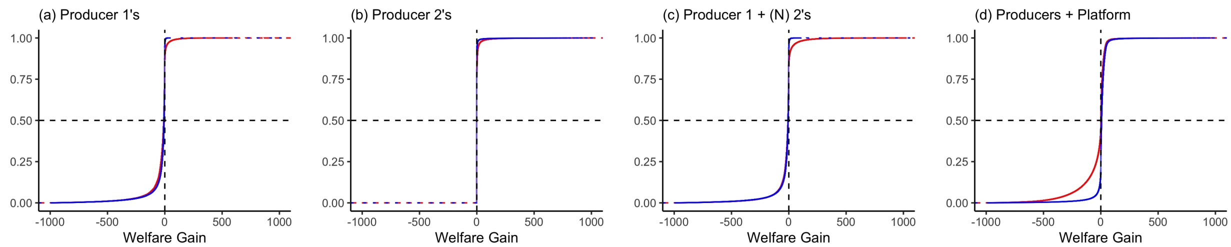


Figure 2: Cumulative distribution of welfare gains across the entire parameter space. The red curve is the full data set (where $c_1 = 10; c_2 \in [c_1, 800)$), and the blue curves adds a filter $\Pi > 0$.

under which the SBO scheme increases producer welfare, and when trade-offs between small and large producers occur. We also demonstrate that being more generous to producers does not necessarily cost the platform and outline the conditions under which the platform can increase profits by adopting this scheme.

Table 1 demonstrates the surprising aspects of an SBO scheme: the SBO schemes can propel greater participation and increased output from both producer types, and all parties can be better off under it including the platform and larger producer! Figure 2 confirms that the counter-intuitive and complex effects of the SBO scheme: despite giving higher revenue share to producers, it can reduce profit not just of producer 1 (panel a) but also aggregate producers profit (panel c); in a minority of cases, SBO reduces total industry welfare (i.e., producers + platform) especially when the platform requires a positive profit gain (panel d). To understand why and to explore more broadly, we probe the deeper workings of the SBO scheme to understand how it affects different parts of the platform ecosystem.

4.1 Ecosystem Participation, Scale, and Market Concentration

Given the discrete setting (two producer-types), an increase in ecosystem participation can manifest only when type-2 producers were *not* viable under a single-rate, i.e., when $c_2 > \frac{c_1}{\theta}$. Then, differential revenue-sharing enhances the region for producer 2's viability to the looser constraint $c_2 < \frac{c_1 \eta/\gamma}{\theta}$. Combined with Theorem 2 this implies that differential sharing expands the producer ecosystem (while maintaining a potential for increasing profit) when the platform can set η such that $c_2 \in [c_1\eta/\gamma, \frac{c_1\eta/\gamma}{\theta}]$. Regarding ecosystem output, an SBO scheme can cause an increase both when both producers were initially viable and when only producer 1 was viable under single rate.

Proposition 1 (Impact on Producer Ecosystem Participation and Output)**.** *The SBO differential-rate scheme (weakly) increases producer participation and total output relative to the single-rate scheme.*

Next, consider the SBO scheme's impact on ecosystem concentration (relative output of producer types).[12] The higher marginal rate η motivates higher output by small producers, but this effect is tampered because marginal revenue decreases as output increases. Larger producers still face the same marginal rate γ, hence η does not directly affect their output although they receive an extra payoff $(\eta - \gamma)S$. Their equilibrium output can either a) increase, due to a spillover effect (more output from small producers increases total consumer traffic and leads to higher revenue available for sharing) or b) decrease, due to being crowded out and facing greater competition (and reduced marginal revenue) with the increased output of smaller producers. The net effect of combining these economic forces is stated below.

Proposition 2 (Impact on Producer Ecosystem Concentration)**.** *The SBO differential-rate scheme induces higher output from smaller producers and reduces market concentration in the producer ecosystem, giving smaller producers higher share of platform output and revenue than a single rate.*

4.2 Impact on Platform Profit and Producers' Welfare

As the fuel of platform activity and revenue, higher ecosystem participation and output are in the long-term interest of the platform, and so is reduction in concentration within the producer ecosystem. But, what about the operational or short-run profit? Defining the platform's operational profit gain $\Delta\Pi = (\tilde{\Pi} - \Pi^*) = (\tilde{\Pi} - \tilde{\Pi}(\eta = \gamma))$, we show strong evidence supporting that "being good

[12]The result is trivial when only type-1 producer was viable initially and accounted for 100% of the output, because then there's only one direction for change in market concentration.

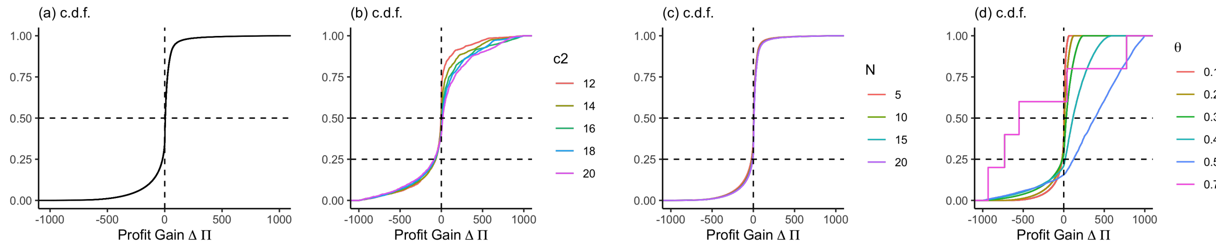


Figure 3: Cumulative distribution of platform's profit gain $\Delta\Pi$ from differential revenue-sharing.

to producers" can also be good for the platform. Given the complexity of comparing the high-order polynomial in Eq. 6, Corollary 1 relies on analysis of the parameter space Λ.

Corollary 1 (Profit Gain)**.** *The platform's profit gain from differential sharing with SBO rate η,*

$$\Delta\Pi = \beta(1-\gamma)\left[\left(\frac{\gamma\beta(N+\theta)}{c_1 + Nc_2\gamma/\eta}\right)^{\frac{\theta}{1-\theta}} - \left(\frac{\gamma\beta(N+\theta)}{c_1 + Nc_2}\right)^{\frac{\theta}{1-\theta}}\right] - (\eta-\gamma)(1+N)S \tag{6}$$

is more often positive than negative in the parameter space Λ.

Figure 3 presents a visual summary of the distribution of $\Delta\Pi$, first across the entire parameter space (panel (a)) and then for projections that probe the distribution for specific values of parameters c_2, N, and θ. Notice that the SBO differential scheme produces a profit gain more often than not. Further, note that the likelihood of a profit gain is lower when θ is high (panel (d)); this is because (from Eq. 5b, Eq. 5c) type-1 producer dominates under higher θ so much that our stylized two-type ecosystem model approaches a single-type ecosystem, leaving less room for improvement. Since the above distributions cover *all* values of the decision variable η (rather than just at the optimal value), we find that for every optimal single-rate design (γ^*, equivalently θ), the platform has substantial freedom to set η that delivers higher profit.

The aggregate behavior described in Figure 3 masks some important details regarding how each parameter affects the outcome. Specifically, consider the effect of the level of c_2 (keeping c_1 fixed) on the consequences of the SBO scheme. Given c_1, the parameter space for $c_2 > c_1$ consists of two parts: i) $c_2 \in (c_1, \frac{c_1}{\theta})$ such that type-2 producers are viable under the single-rate scheme, and ii) $c_2 \in (\frac{c_1}{\theta}, \frac{c_1\gamma/\eta}{\theta})$ where type-2 producers are viable only under the SBO scheme. We use Figure 4

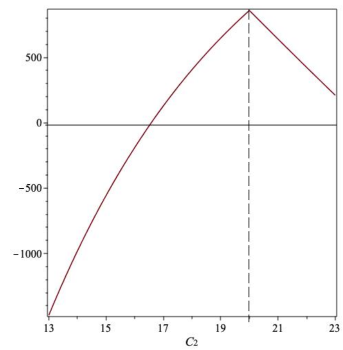


Figure 4: Difference in Platform's Profit While Changing c_2 with a reference line at 0 ($\beta = 1000$, $\gamma = 0.5$, $\theta = 0.5$, $c_1 = 10$, $c_2 \in [13, 23]$ $\eta = 0.6$, and $N = 1$. The varying variables satisfy the conditions that ensure $Q_1^* \geq Q_2^* > 0$. Market expansion happens when $c_2 > 20$.)

to demonstrate that the SBO scheme can increase the platform's profit in both cases, and that the profit gain is increasing with c_2 in case (i) and decreasing in case (ii). In other words, when smaller producers are already in the ecosystem, the weaker they are (i.e., higher c_2) the more valuable it is to empower them; but using the SBO rate to *bring* smaller producers into the ecosystem becomes increasingly more expensive when they're too weak.

The insight derived from the examples in Figure 4 can be generalized and explained as follows. When producers are relatively homogeneous (i.e., c_2 is close to c_1, and implying a small relevant range for picking $\eta > \gamma$), then the increased production by type-2 producers primarily has a crowding-out effect leading to lower output from type-1 producer. The platform benefits little (or even negatively) in this situation, because of limited increase in Q and because it pays the higher rate η for the bulk of Q. At the other extreme, when producers are sharply heterogeneous (i.e., c_2 very high relative to c_1, and with type-2 producers unviable under the single-rate scheme) then again the SBO scheme doesn't benefit the platform much because it requires high η to incentivize entry by type-2 producers and there is little impact on overall Q. When there's moderate heterogeneity among producers, then the platform profit is more likely to increase because the spillover effects dominate: the SBO scheme leads to sufficiently higher output bringing in more consumers and higher revenue potential, either with i) market expansion (entry by type-2 producers, more likely under higher θ) or ii) merely output expansion especially by type-2 producers (under lower θ). Our next result relates producer heterogeneity with the SBO scheme's attractiveness to the platform.

Proposition 3 (Impact on Platform's Profit)**.** *For the platform, an increase in profit is most likely when producer 2's cost parameter is moderately higher than producer 1, and when the proportion of smaller producers is not too small.*

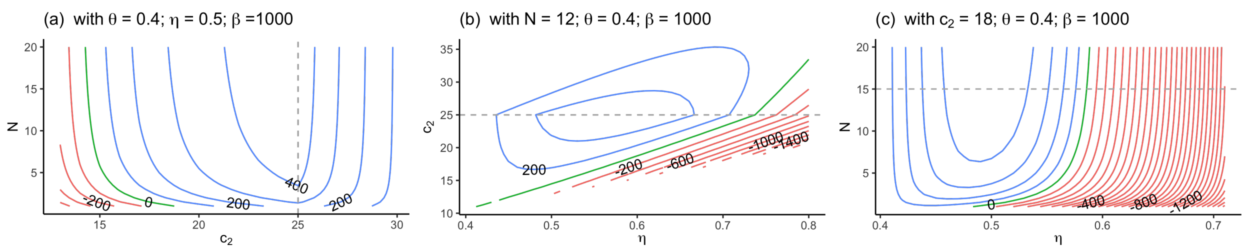


Figure 5: Absolute increase in platform profit from SBO revenue-sharing: how it varies with N and c_2 and choice of η (Producers 2 are not viable when $c_2 > 25$ under the single rate scheme). Each contour curve represents a combination of two variables that generate the same metric value (increase in platform profit). The text on the contours denotes the increase in platform profit, with blue representing a gain, green reflecting zero, and red representing a loss.

Figure 5 examines the impact of the SBO scheme along multiple dimensions. Panel (b) generalizes panel (b) in Figure 4, illustrating that the profit gain is non-monotonic in η (first increasing, then decreasing) which is a decision variable for the platform. It suggests that there is a "sweet spot" when choosing the favorable SBO rate; however, the notable point is that a profit gain is possible even for other η values around the optimal one. The other panels of Figure 5 provide a more comprehensive perspective. In panel (c), following a horizontal line for some N (e.g., c_2=15) we see that setting $\eta > \gamma$ initially increases profit, with more gain as η increases, but then the gain reduces as η increases further. The reason is that too high η limits gain (or causes a loss) by giving away too much of the pie to producers, and too low gives away a revenue share without adequate return in terms of higher output. Panels (a) and (c) both show that as N increases, the platform's profit gain increases (either from negative to positive; or in the positive region).

Next, Figure 6 provides a detailed analysis of market conditions under which an SBO restruc-

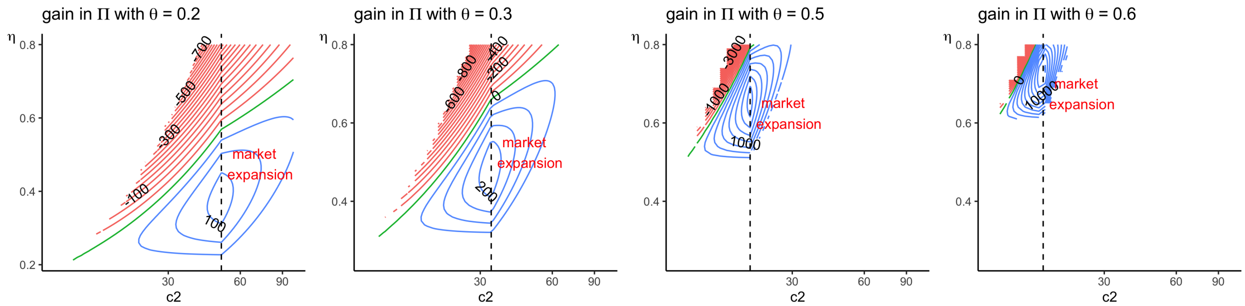
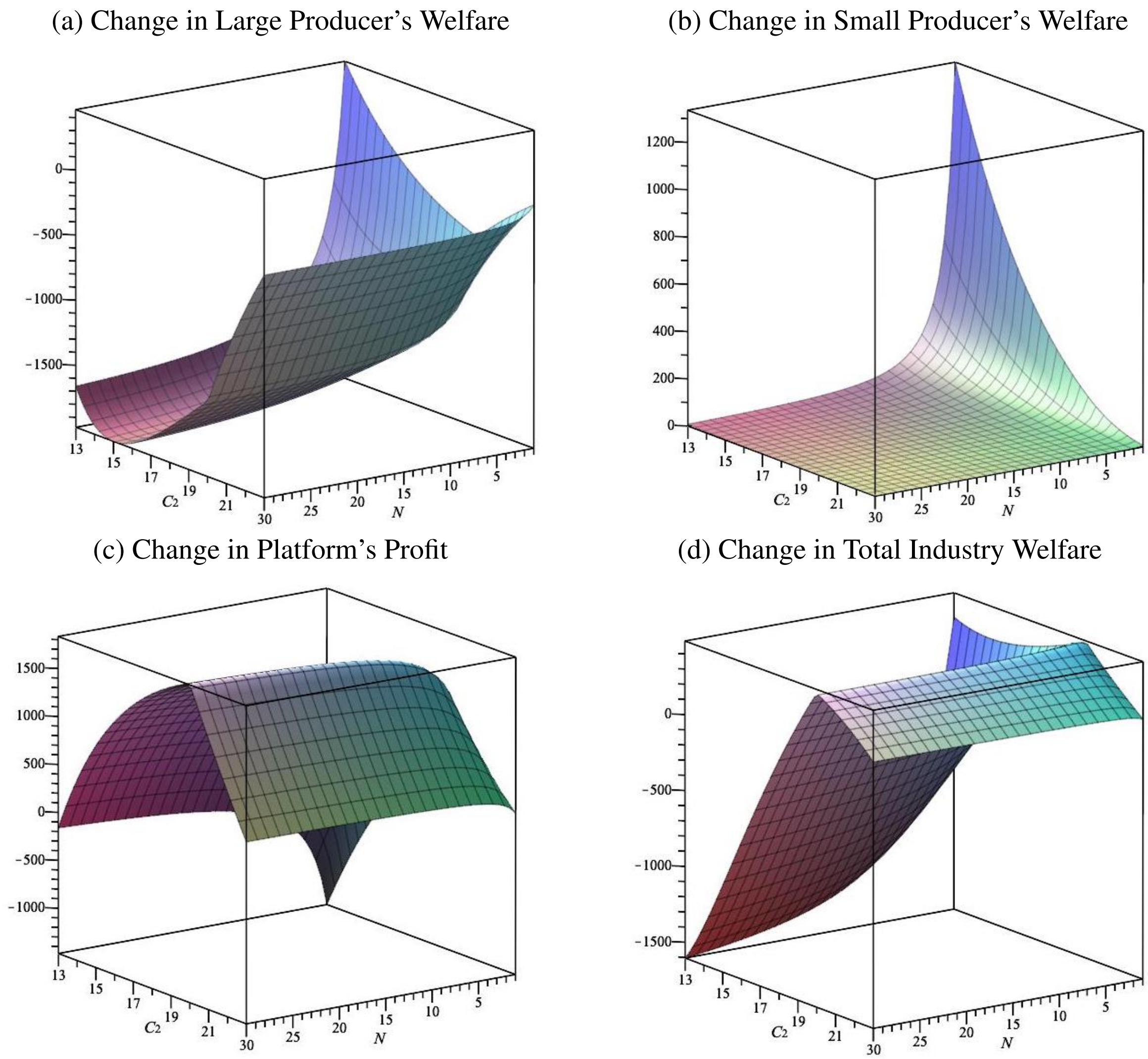


Figure 6: Platform's potential for increasing absolute profit via SBO scheme under various levels of θ. Market expansion happens at the region right to the vertical dashed line. Note that c_2 is in a logarithmic scale. Each contour curve represents a combination of two variables that generate the same metric value (increase in platform profit). The text on the contours denotes the increase in platform profit, with blue representing a gain, green reflecting zero, and red representing a loss.

turing can increase the platform's profit. Since the effects of β and N are relatively straightforward, we fix these two values and examine the behavior against the platform market characteristic θ, producer heterogeneity c_2, and the platform's design variable η. The region to the right of the dashed black line is where the SBO scheme leads to market expansion (bringing in previously unviable type-2 producers); we see that higher θ implies a smaller c_2 range under which the platform's profit increases and doing so requires higher η. The region on the left represents gains due to increased output from type-2 producers (and increased Q overall). Note also that increasing η delivers increased gains to the platform up to a point and then decreasing.

Figure 7 summarizes how the SBO scheme affects welfare across the ecosystem, and how these effects vary with the proportion of small creators (N) and their production cost (c_2). Small creators naturally gain from the more favorable rate (panel b). Surprisingly, the larger creator can sometimes also benefit despite higher output from smaller producers (panel a); this occurs when the two types are relatively homogeneous (i.e., relative size N is small and c_2 is close to c_1). An increase in platform's profit is most likely when c_2 is moderately high and N is not too small (panel c). Panel (d) plots the total industry welfare difference (for the producers and the platform), and it is obvious that moving to differential revenue sharing overwhelmingly increases industry welfare, and the platform is the biggest winner.



(a) Change in Large Producer's Welfare

(b) Change in Small Producer's Welfare

(c) Change in Platform's Profit

(d) Change in Total Industry Welfare

Figure 7: Difference in Welfare While Changing c_2 or η ($\beta = 1000$, $\gamma = 0.5$, $\theta = 0.5$, $\eta = 0.6$, $c_1 = 10$, $c_2 \in [13, 23]$ and $N \in [1, 30]$. The varying variables satisfy the conditions that ensure $Q_1^* \geq Q_2^* > 0$. Market expansion happens when $c_2 > 20$.)

5 Conclusion

Major digital platforms that attract users with goods from third-party producers employ revenue-sharing schemes with a single commission rate to incentivize producer participation and contribution. Such a scheme not only fails to suitably account for heterogeneity within the platform's ecosystem of producers, but is also a focal point of complaints about excessive power wielded by these platforms. This paper has examined a differential rate revenue sharing design which aims to benefit smaller (less endowed) producers in the ecosystem by returning a higher revenue-sharing rate upto a contribution threshold. Our analyses uncover some interesting insights. First, we show that often, the platform can increase producers' output and its own profit. These gains are driven by an interplay of the competitive effect between producers with a value co-creation or spillover effect where higher output invites more user traffic and revenue on the platform and the consequent potential for increased shared revenue leads to even higher contribution from producers. Second, subsidizing smaller businesses (without directly punishing the large businesses) helps to equalize producers' capability to compete on the platform. Since every producer's payoff is affected by the levels of the output produced by others, a more equalized competitive environment encourages higher production levels, and subsequently higher profits. Third, we demonstrate that while it is possible for all parties to gain from a shift in the revenue sharing design, the platform is often the biggest winner. Indeed the true provider of the subsidy provided by the higher revenue-share rate is more often the larger producers than the platform!

Our analyses shed light on the real consequences of this increasingly popular strategy with which large tech firms such as Apple and Google seem to have fended off their critics. The allegations they face are about the power they possess—exclusive ownership of producer data, restricting the channels through which consumers can access products on a platform—which empower the platform to extract a high tax from producers. The SBO scheme might appear to be a concession against this power. However, our model demonstrates that it is debatable if "giving away more money" is in fact instrumental in reducing monopoly power. On the contrary, a platform often gains more from this revenue sharing restructuring. It also suggests that a "be more generous" imposition on a platform need not be a top-down decision from lawmakers or regulators. Instead, it can be a market driven decision that benefits not only the producers but also the platform.

Although derived in a two-producer setting, our results provide important insights about an SBO scheme's effects in a more general multi-producer-types market. The two extreme cases in Proposition 3—c_2 close to c_1 and c_2 so high that producer 2 is unviable in the market—both imply a homogeneous producer market. Hence the result's extension to the multiple-types case is the tautology that a differential rate scheme is more impactful (and more likely profitable for the platform) when there is heterogeneity in the producer market. However, unlike the "quantity discounts" that are preponderant in differential pricing under heterogeneity and which favor the "richer" agents, the SBO scheme has a critically distinctive policy and equity role: it favors the smaller or weaker agents, helps to create a more level playing field, and reduces market concentration (Proposition 2), in addition to increasing total market output (Proposition 1). Our analyses demonstrate that there exist SBO designs that enhance the welfare of both the platform and producers, and there are designs that favors the platform more than the producers. Our findings can assist policy makers in crafting practical revenue sharing designs that satisfy social needs.

References

Balseiro, Santiago, Max Lin, Vahab Mirrokni, Renato Paes Leme, and Song Zuo (Apr. 2017). "Dynamic Revenue Sharing".

Bart, Nelly, Tatyana Chernonog, and Tal Avinadav (Sept. 2020). "Revenue-sharing contracts in supply chains: a comprehensive literature review". In: *Int. J. Prod. Res.*, pp. 1–26.

Bhargava, Hemant K. (Apr. 2021). "Bundling for Flexibility and Variety: An Economic Model for Multiproducer Value Aggregation". In: *Management Science* 67.4, pp. 2365–2380.

Bhargava, Hemant K. (2022). “The Creator Economy: Managing Ecosystem Supply, Revenue-Sharing, and Platform Design”. In: *Management Science (forthcoming)*.

Bhargava, Hemant K. and Vidyanand Choudhary (2004). “Economics of an Information Intermediary with Aggregation Benefits”. In: *Information Systems Research* 15.1, pp. 22–36.

Cusumano, Michael A, David B Yoffie, and Annabelle Gawer (2019). *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power*. HarperCollins Publishers.

Haviv, Avery, Yufeng Huang, and Nan Li (Oct. 2020). “Intertemporal Demand Spillover Effects on Video Game Platforms”. In: *Manage. Sci.* 66.10, pp. 4788–4807.

MacDonald, Glenn and Michael D Ryall (Oct. 2004). “How Do Value Creation and Competition Determine Whether a Firm Appropriates Value?” In: *Manage. Sci.* 50.10, pp. 1319–1333.

Maskin, Eric and John Riley (Summer 1984). “Monopoly with Incomplete Information”. In: *Rand Journal of Economics* 15.2, pp. 171–194.

Oh, Jungsuk, Byungwan Koh, and Srinivasan Raghunathan (Sept. 2015). “Value appropriation between the platform provider and app developers in mobile platform mediated networks”. In: *Journal of Information Technology Impact* 30.3, pp. 245–259.

Oren, Shmuel S., Stephen A. Smith, and Robert A. Wilson (Summer 1982). “Nonlinear Pricing in Markets with Interdependent Demand”. In: *Marketing Science* 1.3, pp. 287–313.

A Proofs

Proof of Lemma 1. In the producer-level subgame, producer j picks Q_j to maximize its profit π_j considering the simultaneous choices Q_{-j} of all other producers and the platform revenue $R(Q)=\beta Q^\theta$. Since $\pi_j = \gamma \frac{Q_j}{Q} \beta Q^\theta - c_j Q_j$, the first-order conditions (FOC, $\frac{\partial \pi_j}{\partial Q_j} = 0$) yield a system of equations $c_j = \frac{\gamma\beta}{Q^{2-\theta}}(Q - (1-\theta)Q_j)$. The individual rationality (IR) constraints are $c_j \leq \frac{\gamma\beta}{Q^{1-\theta}}$. There are $N+1$ producers that satisfy the IR constraint in equilibrium (1 type-1 producer and N type-2 producers). Then, adding the all $N+1$ FOC equations yields $(Q^*)^{1-\theta} = \gamma\beta \frac{N+\theta}{c_1+Nc_2}$. Q_j^* is obtained by substituting for Q^* in the FOC for producer j. Π^* is obtained by substituting Q^* in Eq.1. At the equilibrium, the IR constraints become $c_j \leq \frac{c_{-j}}{\theta}$. By definition, $c_1 < c_2 < \frac{c_2}{\theta}$. If $c_2 \leq \frac{c_1}{\theta}$, producer 2 will not produce and is not viable. ■

Proof of Lemma 2. First, note that S must fall between the two producer-types' revenue-shares: i.e., $S \geq \frac{Q_2}{Q}R(Q)$ and $S \leq \frac{Q_1}{Q}R(Q)$; moreover, this property should hold for the *equilibrium* values of Q_j, i.e., $S \in [\frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q}), \frac{\tilde{Q}_1}{\tilde{Q}}R(\tilde{Q})]$. This is because i) $S > \frac{\tilde{Q}_1}{\tilde{Q}}R(Q)$ would reduce the design to a single-rate design with rate η ($> \gamma$), which is obviously sub-optimal relative to the optimal rate $\gamma^* = \theta$, and ii) $S < \frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ would simply transfer more surplus from the platform to producers without motivating any increase in output. Second, S should exactly equal $\frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ because any $S > \frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$ would, again, transfer unnecessarily high surplus to producer 1 without affecting outputs relative to $S = \frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$. Regarding the favorable rate η, the range $\eta > \frac{c_2\gamma}{c_1}$ is eliminated as follows. Compute first-order optimality conditions for producer 1, and substituting the identity $S = \frac{\tilde{Q}_2}{\tilde{Q}}R(\tilde{Q})$, yields (when $\eta > \frac{c_2\gamma}{c_1}$) $\tilde{Q}_1 = \frac{\tilde{Q}}{1-\theta}\left(1-\frac{c_1\tilde{Q}^{1-\theta}}{\gamma\beta}\right) < \frac{\tilde{Q}}{1-\theta}\left(1-\frac{c_2\tilde{Q}^{1-\theta}}{\eta\beta}\right) = \tilde{Q}_2$ (the last equality arising from FOC for type-2), which is a contradiction. In other words, for any $\eta > \frac{c_2\gamma}{c_1}$, the platform is better off picking a lower value of $\eta = \frac{c_2\gamma}{c_1}$. ■

Proof of Theorem 1. In this revised producer-level subgame, the platform returns revenue βQ^θ (without the γ fractional multiplier) to producers. Hence producer j (with cost $\frac{c_j}{\gamma}$ picks Q_j to maximize its profit $\pi_j = \frac{Q_j}{Q}\beta Q^\theta - \frac{c_j}{\gamma}Q_j$, the first-order conditions are the same as in Lemma 1, $c_j = \frac{\gamma\beta}{Q^{2-\theta}}(Q - (1-\theta)Q_j$. The individual rationality (IR) constraints can also be written in the same form, $c_j \leq \frac{\gamma\beta}{Q^{1-\theta}}$. Hence the remaining computations and equilibrium properties are identical to the problem in the Lemma. ■

Proof of Theorem 2. First, with Lemma 2, an SBO differential rate scheme is meaningful only for (η, S) that produce a separating equilibrium in which producer 2 receives rate η for its entire output Q_2 and producer 1 has at least some higher output that receives the lower rate γ. Computing producers' first-order optimality conditions under the differential rate scheme yields

$c_1 = \frac{\gamma\beta}{Q^{2-\theta}}(Q - (1{-}\theta)Q_1)$ and $c_2 = \frac{\eta\beta}{Q^{2-\theta}}(Q - (1{-}\theta)Q_2)$. Rewrite the latter equation as $c_2\frac{\gamma}{\eta} = \frac{\gamma\beta}{Q^{2-\theta}}(Q - (1{-}\theta)Q_2)$. Applying Theorem 1, this is equivalent to a scenario in which producers' cost parameters are $(c_1, c_2\frac{\gamma}{\eta}$, as long as $c_1 < c_2\gamma/\eta$ which is ensured in Lemma 2. As an aside the same subgame equilibrium in output levels is obtained even when the differential rate scheme is set up such that producer 1 is given the rate γ for its entire output (rather than just the increment about S).

■

Proof of Proposition 1. For ecosystem participation, the more favorable participation condition ($c_2 < \frac{c_1\eta/\gamma}{\theta}$) makes it more likely for type-2 producers to remain viable. For total output, Eq. 5a confirms that $\tilde{Q} > Q^*$ because the former has a smaller denominator than the latter, which is simply $\tilde{Q}$ with $\eta{=}\gamma$. ■

Proof of Proposition 2. From Eq. 5b, the ratio $\frac{\tilde{Q}_1}{\tilde{Q}}$ decreases as η increases, hence producer 1's share of output is lower than under the single-rate scheme; trivially, therefore, type-2 producers now have higher share, lowering market concentration among producers. Next we look at absolute levels of output. The key idea underlying the proof is producers' contributions are proportional to its output level. With smaller share of total output, type-1 producer takes smaller portion of revenue than under the single rate scheme. In contrast, type-2 producers contributes more output, therefore increasing their revenue take. ■

Proof of Proposition 3. We express the platform's profit gain as

$$\begin{aligned}\Delta\Pi = \Pi_d - \Pi_s &= \beta Q_d^{\theta}(1{-}\gamma) - (\eta{-}\gamma)(1{+}N)S - \beta Q_s^{\theta}(1{-}\gamma)\\ &= \underbrace{\beta(1{-}\gamma)(Q_d^{\theta} - Q_s^{\theta})}_{\mathbf{A}} - \underbrace{(\eta{-}\gamma)(1{+}N)S}_{\mathbf{B}},\end{aligned}$$

where Π_d and Π_s are the platform's profit under the differential rate and the single rate, respectively, while Q_d and Q_s are corresponding outputs. **A** denotes the profit gain from increasing total output, and **B** is the profit loss from providing a higher differential rate to the first S revenue.

Our technique to prove this result is to show that an SBO design delivers no profit increase to the platform when c_2 is either closest to c_1 (less heterogeneity among producers) or extremely far (very high heterogeneity), and that it can deliver a profit gain when c_2 is in the middle. First, if c_2=c_1, then trivially there is no advantage from setting η higher than the optimal γ^*. Qualitatively, even when c_2 is close to c_1 (without being equal), the SBO scheme essentially forces the platform to pay the higher rate η for the bulk of total output it secures with Q_d^θ not much higher than Q_s^θ (**B** higher than **A**), hence there is only a loss in platform profit in such cases. Second, if c_2 is so high (corresponding to chosen η) that producer 2 is not viable even under the SBO scheme, then again there is no advantage to the platform. Again, the general point is that as c_2 gets very high, the platform has to set very high η and give away substantial revenue-share to both producers. Finally, we know (i.e., an example would be sufficient to prove) that there do exist moderate c_2 values for which there is a positive platform gain. When N is too small, the large producer dominates total output. Although a higher η implies higher output from small producers (or market expansion with their entry), their output expansion is not enough to increase revenue. Hence the result. ■