Self-Preferencing and Welfare in Hybrid Platforms

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Hybrid Platforms and Self-Preferencing

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  - 1P listings: limited in variety.
  - 3P listings: expand variety, but crowd out 1P sales.
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- A model of a monopolistic hybrid platform that features: **free entry of 3P sellers / double marginalization / control over listing visibility**
- When is it profitable for the hybrid-platform to SP?
- Welfare consequences of banning SP?

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- We identify sufficient conditions under which a ban lowers both consumer surplus and welfare.

A Model of Hybrid Platform
(no self-preferencing)

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- The platform owns a measure $h > 0$ (exogenous) 1P listings.
- Each 1P listing is a unique variant, constant cost c.
- The platform charges percentage fee $\gamma \in (0, 1)$ on 3P sales and retail price for 1P listings.

Set-up (continue)

- The platform uses an algorithm to recommend products to consumers. Sellers (1P and 3P) then set a price p to maximize profits.
- Given b buyers and $h+s$ listings, $M(b, h+s)$ denotes the number of successful recommendations.
- Each listing obtains μ^s buyers:

$$\mu^s(b, h+s) \equiv M(b, h+s)/(h+s).$$

- We assume:
  - $M(\cdot)$ is twice differentiable, increasing in both arguments.
  - $\mu^s(b, s)$ is decreasing in s.

Micro-foundation for $M(\cdot)$ (I)

- A space of N potential variants. On the platform, H products are 1P listings, S are 3P listings; $H + S < N$.
- Each buyer has a consideration set Ω (size $|\Omega|$)
- The probability that the algorithm can find at least one variant in Ω among the $H + S$ variants:

$$\mu^b(H+S) = \zeta\left(1 - (1 - (H+S)/N)^{|\Omega|}\right),$$

where $\zeta \in (0, 1]$: the algorithm efficiency.

- In the large market limit ($N \to \infty$, $H/N \to h$, $S/N \to s$),

$$\mu^b(h+s) = \zeta\left(1 - e^{-(h+s)\omega}\right), \quad M(\cdot) = b \cdot \mu^b$$
$$\mu^s(b, h+s) = b \cdot \zeta\left(1 - e^{-(h+s)\omega}\right)/(h+s).$$

Micro-foundation for $M(\cdot)$ (II)

- There are b buyers, $h+s$ listings. For any buyer-listing pair, matching Prob. q is i.i.d. drawn from a distribution with c.d.f. $F(q)$ on $[0,1]$.
- After q's are realized, the platform recommends the listing with the highest match probability:

$$q_{max} = \max_i \{q_i\}.$$

- Ex-ante, the expected matching Prob. for a buyer:

$$\mathbb{E}[q_{max}] = 1 - \int_0^1 [F(q)]^{h+s} dq.$$

- Total successful recommendations:

$$M(b, h+s) = b \cdot \left(1 - \int_0^1 [F(q)]^{h+s} dq\right)$$

Discussions of $M(\cdot)$

- Focus on the Visibility channel
  - Motivated by platforms where visibility is a prerequisite for sales and often outweighs price competition.
  - Examples: Amazon's Buy Box, Booking.com's Rankings.
- Assume no Direct Pricing channel
  - We abstract away from using fees (γ) purely to raise 3P prices and divert demand to 1P.

Timing

1. The platform announces the commission rate γ.
2. Observing γ and $M(\cdot)$, 3P sellers simultaneously decide whether to enter the platform.
3. The platform uses algorithm M to recommend products to buyers.
4. Sellers (1P and 3P) set prices p; matched buyers purchase $D(p)$.

Solution concept:

- Subgame perfection

Equilibrium

Pricing of 1P and 3P vendors

- 1P vendor profit-maximization:

$$\pi_M = \max_p \, (p - c)D(p).$$

- 3P vendor profit-maximization (taking γ as given):

$$\pi_S(\gamma) = \max_p \, [p(1-\gamma) - c]D(p) \;\; \Rightarrow \text{optimal price: } p_s(\gamma).$$

- The platform's fee revenue from each match:

$$\pi_P(\gamma) = \gamma p_s(\gamma) D(p_s(\gamma)).$$

- Define $\hat{\gamma}$: the rate that maximizes the per-match fee revenue

$$\hat{\gamma} \equiv \arg\max_{\gamma} \pi_P(\gamma).$$

The Platform's Problem

- The free-entry condition for 3P sellers

$$\mu^s(b, h+s) \cdot \pi_S(\gamma) = k$$

pins down the measure of entering sellers: $s = s_0(\gamma)$, satisfying $\frac{\partial s_0(\gamma)}{\partial \gamma} < 0$.

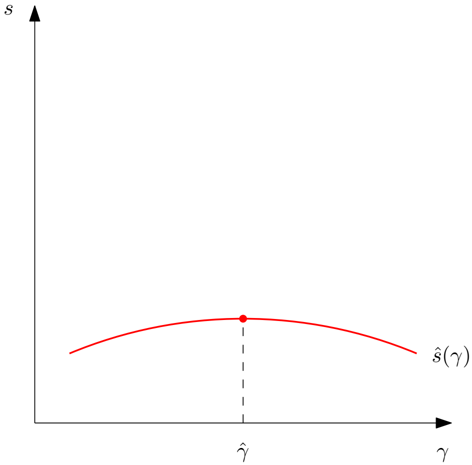
- The platform chooses commission rate γ to maximize profits subject to free-entry condition:

$$\max_{\gamma \in [0,1]} \quad M\Big(b, h+s\Big)\Big(\frac{h}{h+s}\pi_M + \frac{s}{h+s}\pi_P(\gamma)\Big),$$
$$\text{s.t.} \quad s = s_0(\gamma).$$

- Consider the unconstrained problem first:

$$\max_{\gamma,s} \underbrace{M\Big(b, h+s\Big)}_{\text{Market Expansion}} \Bigg(\underbrace{\frac{h}{h+s}\pi_M + \frac{s}{h+s}\pi_P(\gamma)}_{\text{Business-stealing}}\Bigg).$$

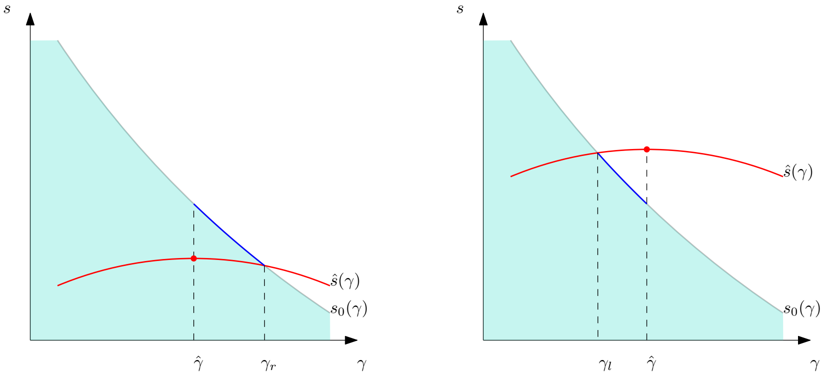
- Market Expansion: $s \uparrow \to M(\cdot) \uparrow$.
- Business Stealing: $s \uparrow \to$ shift the sales mix toward less profitable 3P sellers (since $\pi_M > \pi_P(\gamma)$ for all $0 \leq \gamma \leq 1$).
- Suppose the objective is single-peaked in s and let the optimal solution be $\hat{s}(\gamma)$.
- $\hat{s}(\gamma)$ is single-peaked in γ. When $\hat{s}(\gamma)$ is interior, it is increasing for $\gamma < \hat{\gamma}$ and decreasing for $\gamma > \hat{\gamma}$.



- The unconstrained optimum is $(\gamma^*, s^*) = (\hat{\gamma}, \hat{s}(\hat{\gamma}))$.

- Consider the constrained problem:

$$\max_{\gamma}\ M\Big(b, h+s\Big)\Big(\frac{h}{h+s}\pi_M + \frac{s}{h+s}\pi_P(\gamma)\Big), \text{ s.t. } s = s_0(\gamma).$$



$s_0(\hat{\gamma}) > \hat{s}(\hat{\gamma})$ $\qquad\qquad$ $s_0(\hat{\gamma}) < \hat{s}(\hat{\gamma})$

Self-Preferencing (SP)

Modeling SP

- SP: lower the likelihood that a 3P seller enters the recommendation process from 1 to $\alpha < 1$:

$$M(b, h + \alpha s)$$

- Choosing α is equivalent to choosing the number of 3P sellers that get into the recommendation process, denoted by s_{sp}:

$$\alpha \equiv \frac{s_{sp}}{s_E}.$$

Lemma

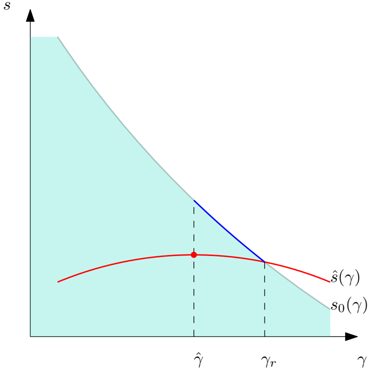
For any given γ, the platform can choose any $s_{sp} \in [0, s_0(\gamma)]$. In particular, $s_E = s_0(\gamma)$ iff $s_{sp} = s_0(\gamma)$; otherwise, $s_E > s_{sp}$.

Timing (updated)

1. The platform announces the commission rate γ and the number of displayed 3P sellers s_{sp}.
2. Observing (γ, s_{sp}) and $M(\cdot)$, third-party sellers simultaneously decide whether to enter the platform.
3. The platform uses algorithm $M(b, h + \alpha s)$ to recommend products to buyers.
4. Sellers (1P and 3P) set prices p; matched buyers purchase the amount $D(p)$.

The platform's problem (allowing for SP)

$$\max_{\gamma\in[0,1], s\in\mathbb{R}_+} M\Big(b, h+s\Big)\Big(\frac{h}{h+s}\pi_M + \frac{s}{h+s}\pi_P(\gamma)\Big), \text{ s.t. } s \leq s_0(\gamma).$$



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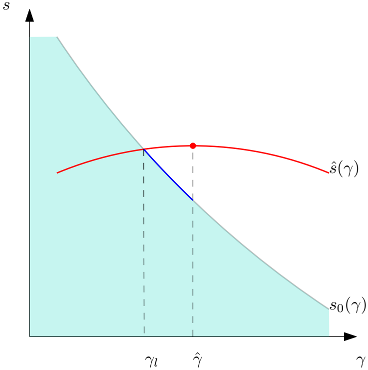

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Proposition (Excessive Entry and SP)

The platform's decision to self-preference depends on the level of entry at $\hat{\gamma}$.

- **Excessive Entry ($s_0(\hat{\gamma}) > \hat{s}(\hat{\gamma})$):** *It is optimal for the platform to self-preference. The platform achieves unconstrained maximum profit by setting $\gamma_{sp} = \hat{\gamma}$ and $s_{sp} = \hat{s}(\hat{\gamma})$.*
- **Insufficient Entry ($s_0(\hat{\gamma}) < \hat{s}(\hat{\gamma})$):** *It is optimal for the platform to* **not** *actively self-preference. The outcome is identical to the no self-preferencing benchmark.*

Proposition (First-party Capacity triggers SP)

If the platform's own capacity h is sufficiently large ($h > \tilde{h}$), self-preferencing becomes profit-maximizing.

- **Higher 1P capacity ($h \uparrow$)**: as 1P capacity increases, both seller entry $s_0(\hat{\gamma}) \downarrow$ and platform optimum $\hat{s}(\hat{\gamma}) \downarrow$.
- But the platform wants sellers to exit faster than they naturally do since 1P has a higher profit margin:

$$\underbrace{\frac{\partial s_0(\hat{\gamma})}{\partial h} = -1}_{\text{Seller Natural Exit}} \quad > \quad \underbrace{\frac{\partial \hat{s}(\hat{\gamma})}{\partial h}}_{\text{Platform Optimal Exit}}$$

Corollary (Low Demand and Entry Cost Trigger SP)

If the market demand (b) is sufficiently low, or if the seller entry cost (k) is sufficiently low, the platform engages in self-preferencing.

- **Low Demand ($b \downarrow$):** As the market shrinks, the platform's desire for variety ($\hat{s}$) drops faster than the sellers' willingness to enter (s_0).
- **Low Entry Cost ($k \downarrow$):** Low costs trigger a flood of entrants ($s_0 \uparrow$), but the platform's ideal number of sellers ($\hat{s}$) is unchanged, creating a massive "excessive entry" gap.

Welfare Analysis

Social Planner

The planner's problem is

$$\max_{\gamma,s} \quad \underbrace{M(\cdot)\left\{\frac{h}{h+s}\Big(\pi_M + cs_M\Big) + \frac{s}{h+s}\Big(\pi_P(\gamma) + cs_S(\gamma)\Big)\right\}}_{\equiv W(\gamma,s)}$$

subject to $s \leq s_0(\gamma)$.

- Fee distortion: The platform sets γ too high (exacerbates the double marginalization and lowers the consumer surplus).
- Quantity distortion: For given γ, platform chooses s_{sp} based on π_M versus π_P only. **The platform lists too many 3P sellers iff**

$$\frac{cs_S(\gamma)}{cs_M} < \frac{\pi_P(\gamma)}{\pi_M}.$$

Banning SP

- Focus on excessive entry scenario $s_0(\hat{\gamma}) > \hat{s}(\hat{\gamma})$.
- Welfare **with SP**: $W_{sp} \equiv W(\hat{\gamma}, \hat{s}(\hat{\gamma}))$.
- Welfare after **banning SP**: $W_b \equiv W(\gamma_{nsp},\ s_0(\gamma_{nsp}))$.
- Welfare change of banning SP is $W_b - W_{sp}$:

$$\underbrace{W(\gamma_{nsp},\ s_0(\gamma_{nsp})) - W(\hat{\gamma},\ s_0(\gamma_{nsp}))}_{\text{Fee Effect}(<0)}$$
$$+\underbrace{W(\hat{\gamma},\ s_0(\gamma_{nsp})) - W(\hat{\gamma},\ \hat{s}(\hat{\gamma}))}_{\text{Quantity Effect (ambiguous sign)}}.$$

Lemma

There exist h_0 and h_1, satisfying $\tilde{h} < h_0 \leq h_1 < \overline{h}$, such that

- *Banning SP leads to more entry ($\hat{s}(\hat{\gamma}) \leq s_0(\gamma_{nsp})$) if $h \leq h_0$;*
- *Banning SP leads to less entry ($\hat{s}(\hat{\gamma}) \geq s_0(\gamma_{nsp})$) if $h \geq h_1$.*

Recall that $0 < \tilde{h} < \bar{h}$ such that

- $h \leq \tilde{h}$: No SP due to insufficient entry;
- $h \geq \bar{h}$: Only 1P sales, and deter all third-party entry.

The Quantity Effect $W(\hat{\gamma},\ s_0(\gamma_{nsp})) - W(\hat{\gamma},\ \hat{s}(\hat{\gamma}))$ is negative if either:

1. Platform lists too many sellers, a ban increases entry further
   $h < h_0$ and $\frac{cs_S(\hat{\gamma})}{cs_M} < \frac{\pi_P(\hat{\gamma})}{\pi_M} \Rightarrow s_0(\gamma_{nsp}) > \hat{s}(\hat{\gamma}) > s_w(\hat{\gamma})$
2. Platform lists too few sellers, a ban reduces entry further
   $h > h_1$ and $\frac{cs_S(\hat{\gamma})}{cs_M} > \frac{\pi_P(\hat{\gamma})}{\pi_M} \Rightarrow s_0(\gamma_{nsp}) < \hat{s}(\hat{\gamma}) < s_w(\hat{\gamma})$

These conditions suffice for a ban to reduce both **welfare and consumer surplus**.

Conclusion

- SP is a tool to manage excessive seller entry.
- Banning SP substitutes visibility control with price control, thus exacerbating double marginalization.
- High commission fees can cause 3P seller entry to deviate further from the social optimum than they would under self-preferencing.