Competition Through Recommendations

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Berlin Micro Theory Seminar

Roadmap

Introduction

Motivation

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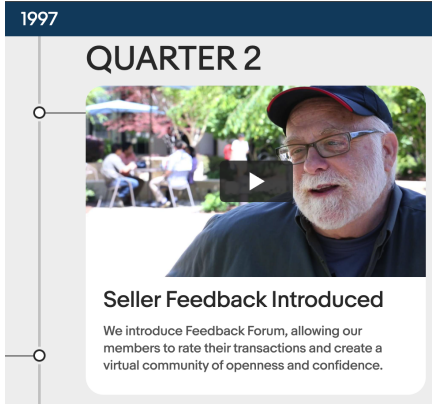

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- Historical problem: How to *foster* trust on the internet?
  - Simple (lowest price first) lists $\Rightarrow$ reputation and recommender systems.
    - Improved profits and higher consumer trust.
    - Reputation $\Longleftrightarrow$ feedback $\Longleftrightarrow$ value

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  - Recommender systems showing poorer results.

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- Today: A dreading sense of *enshittification*.
  - Recommender systems showing poorer results.
  - Fear recommender systems form part of platforms' systemic risk.
  - DSA 27: transparency and modification of recommender systems parameters.

Introduction

Approach

- Study the evolution of rec.sys. in a two-sided market.
- Platform decides how well recommender system informs of value.

Questions

- Do monopolist inherently create uninformative rec.sys.?
- Does competition promote informative rec.sys.?
- How do rec.sys. redistribute surplus?
- Discuss the role of regulation.

Preview of results

Mechanism

- More informative rec.sys. induces price competition creating a screening effect.
- Platform's tradeoff: volume — per transaction revenue

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Implications

- Result 1: Monopolist platform prefers rec.sys. more informative than value.
- Result 2: Competition can promote more informative rec.sys.
- Result 3: Informative rec.sys. inordinately benefit highest quality firms.
- Result 4: Transparency can discourage informative rec.sys.

Roadmap

Model (I)

Consumers

- Unit mass each demanding a single unit of product.
- Heterogeneous inertia of joining platform, c_i IID $U[0, 1]$.
- Utility $u_i(\alpha_j, p_j) = \alpha_j - p_j$, α_j quality of firm j and p it's price.
- Mass of consumers joining platform: n.

Drop the j subscript.

Model (II)

Firms

- Unit mass of single product firms.
- Products are homogeneous with heterogeneous quality, α IID $U[0,1]$.
- Only sell on platform, no direct sales.
- Fees: Ad valorem commission fee, r, to platform.
- Marginal cost $= 0$.
- $\pi(D(\alpha, p, \mathbf{p}_{-j}), p) = (1-r)D(\alpha, p, \mathbf{p}_{-j})p$.
- Set of firms joining platform: N.

Model (III)

Platform

- Intermediates between consumers and firms.
- Provides recommendations through product listings.
- $\Pi = r \int_{\alpha_h \forall h \in N} D_h(\alpha_h, p_h, \mathbf{p}_{-h}) p_h \; d\alpha_h$.
- $D_h(\alpha_h, p_h, \mathbf{p}_{-h}) = n\lambda(\alpha_h, p_h, \mathbf{p}_{-h})$.
- $$\lambda(\alpha, p, \mathbf{p}_{-j}, \sigma) = \begin{cases} \frac{\alpha - p - \sigma}{\int_{\alpha h \forall h \in N} \alpha_h - p_h - \sigma \; d\alpha_h} & \text{if } \alpha - p - \sigma \geq 0 \\ 0 & \text{otherwise,} \end{cases}$$

  $\sigma \in \mathbf{R}_+$.

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  $\sigma \in \mathbf{R}_+$.

Note: relative value, positive utility.

Model (IV)

Timing

- Platform announces its recommender system.
- Firms decide to join the platform, setting prices.
  (platform 'learns' firm quality)
- Consumers decide to join the platform, obtains recommendations and consume.

Find SPNE.

Roadmap

Simple recommendations

Lowest-price first

$$\lambda^s(p, \mathbf{p}_{-j}) = \frac{1}{\int_{\alpha_h \forall h \in N} 1 \; d\alpha_h}.$$

- Highly uninformative — Bertrand like competition.

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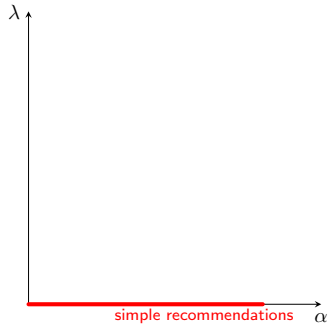

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Equilibrium

- Consumers join the platform if $E[u^s] \geq c_i$.
- Firms set $p^s = 0$.
- $CS = \frac{1}{2}$, firm and platform make zero surplus.

Roadmap

Value recommendations

Fixing $\sigma = 0$:

$$\lambda^v(\alpha, p, \mathbf{p}_{-j}) = \begin{cases} \frac{\alpha - p}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h \ d\alpha_h} & \text{if } \alpha - p \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

- λ^v highlights a ranking effect.

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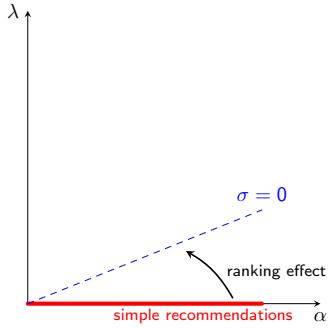

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- λ^v highlights a ranking effect.
  - Higher relative value $\Rightarrow$ higher on the list.
  - Platform can generate utility using informative recommendation rule.

Equilibrium

Consumers

- Always purchase if join the platform.
- $n^v = E[u^v] = \int_{\alpha_g \forall g \in N} \frac{\alpha_g - p_g}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h \ d\alpha_h} (\alpha_g - p_g) \ d\alpha_g.$

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Firms

- $\pi^v = n^v \times \frac{a-p}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h \ d\alpha_h} \times (1-r)p.$
- $p^v = \frac{\alpha}{2}.$

Surplus

- Platform and firm total profits: $\frac{1}{9}$, > 0.
- Consumer surplus: $\frac{1}{3}$, $< \frac{1}{2}$.
- Total surplus: $\frac{4}{9}$, $< \frac{1}{2}$.

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Remark

1. *Platform has an incentive to introduce value rec.sys.*
2. *Relying solely on consumer generated data makes consumers worse-off than simple lists.*

Roadmap

Informative recommendations

$$\lambda(\alpha, p, \mathbf{p}_{-j}, \sigma) = \begin{cases} \frac{\alpha - p - \sigma}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h - \sigma \; d\alpha_h} & \text{if } \alpha - p - \sigma \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

- Higher σ emphasises value.
  - Exacerbates ranking effect.
  - Creates screening effect.

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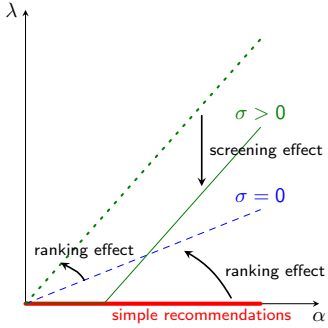

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- Higher σ emphasises value.
  - Exacerbates ranking effect.
  - Creates screening effect.
    - Some lower quality firms obtain no transactions.

Equilibrium (I)

Consumers

- Always purchase if join the platform.
- $n^m = E[u] = \int_{\alpha_g \forall g \in N} \frac{\alpha_g - p_g - \sigma}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h - \sigma \ d\alpha_h} (\alpha_g - p_g) \ d\alpha_g$.

Firms

- $\pi = n^m \times \frac{a - p - \sigma}{\int_{\alpha_h \forall h \in N} \alpha_h - p_h - \sigma \ d\alpha_h} \times (1 - r)p$.
- $p^* = \frac{\alpha - \sigma}{2}$.
  - Set low prices to attract demand, low quality firms become unprofitable.
  - Only sufficiently high quality firms are active on the platform, $\bar{\alpha} = \sigma$.

Equilibrium (II)

Platform

$$\Pi = \int_{\sigma}^{1} \lambda(\alpha_h, p_h^*, \mathbf{p}_{-h}, \sigma)(\alpha_h - p_h^* - \sigma)\ d\alpha_h r \int_{\sigma}^{1} \lambda(\alpha_h, p_h^*, \mathbf{p}_{-h}, \sigma) p_h^*\ d\alpha_h$$

- Balance: Transaction volume and per transaction revenue.

Equilibrium (II)

Platform

$$\Pi = \frac{1+2\sigma}{3} r \frac{1-\sigma}{3}.$$

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- Balance: Transaction volume and per transaction revenue.
- Raising σ:
  - Ranking effect — More transactions between consumers and better firms.
  - Screening effect — Only higher quality firms remain.
  - Price competition — each firm sets lower prices.

Equilibrium (II)

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- Balance: Transaction volume and per transaction revenue.
- Raising σ:
  - Ranking effect — More transactions between consumers and better firms.
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Proposition

There exists a unique SPNE where a monopolist platform sets $\sigma^m = \frac{1}{4} > 0$.

Surplus

Suppose $\sigma \uparrow$:

- Redistribution of profits towards to highest quality firms.
- All other firms worse-off: lower prices, fewer (zero) transactions.
- Consumers face higher quality firms at lower prices (better-off).

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Note: protectionism, variety.

Surplus

Equilibrium

- Total profits $\frac{1}{8}$, $> \frac{1}{9}$.
- Consumer surplus: $\frac{1}{2}$, 'identical' to simple recommendations.
  - *(Postulation)* Better if: positive prices, risk aversion.
- Total surplus: $\frac{5}{8}$, $> \frac{1}{2}$.

Remark

1. *Platform has an incentive to introduce rec.sys. more informative than value.*
2. *Platform preferred rec.sys. allows consumers to be better-off and generates surplus compared to simple recommendations.*

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Remark

DSA Article 27: ability to modify main parameters.

Has no bite? Consumers already better off than when "left to their own devices".

Naivete

Recommender systems are complex:

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Alternate environment:

Consumers do not rationalise equilibrium effect of σ on prices.

- To consumers, $p^c = \frac{\alpha}{2}$.

$$\lambda^c = \begin{cases} \frac{\frac{\alpha}{2} - \sigma}{\int_0^1 \frac{\alpha_h}{2} - \sigma \; d\alpha_h} & \text{if } \alpha - p \geq 0 \\ 0 & \text{otherwise} \end{cases}.$$

Consumers wrongly imagine all firms are active.

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Proposition

When consumers are naive, $\sigma^N \to \frac{1}{4}$ *from below.*

- Consumers and platform are both worse-off than no naivete.

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Proposition

When consumers are naive, $\sigma^N \to \frac{1}{4}$ *from below.*

- Consumers and platform are both worse-off than no naivete.
- DSA Article 27 on transparency:
  Aligned with consumers' concerns.
  Already in line with platform's preference.

Roadmap

Competitor: simple recommendations

Setting

- Suppose there exist two platforms $k \in \{I, C\}$ incumbent and competitor, acting simultaneously.
- Consumers:
  - inertia IID drawn $c_{i,k} \sim U[0, 1]$.
  - Single home — only join platform which gives highest $E[u_k] - c_{ik}$.
- Firms: costless to join platforms, and may choose to multi-home.

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Note: Competitor has no decisions to make, incumbent announces σ.

Equilibrium (I)

Consumers

- Join platform with highest expected utility.
- Buy recommended product.

$$n_k = \begin{cases} E[u_k] - \frac{E[u_{-k}]^2}{2} & \text{if } E[u_k] \geq E[u_{-k}] \\ E[u_k](1 - E[u_{-k}] + \frac{E[u_k]}{2}) & \text{if } E[u_k] < E[u_{-k}]. \end{cases}$$

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Firms

- Positive profit on incumbent, zero profit on competitor.
  Set $p^* = \frac{\alpha - \sigma}{2}$ on incumbent, $p = 0$ on competitor.

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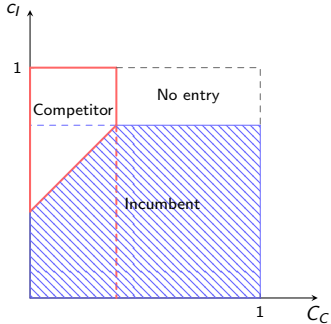
Equilibrium (II)

Proposition

When the competitor adopts simple recommendations, $\sigma_I = \frac{2}{9} < \sigma^m$.

Remark

1. *Competition does not necessarily lead to more informative recommendations.*
2. *Consumer surplus increases — driven by 'new' consumers accessing the competitor* **not** *recommendations.*



Competitor: informative recommendations (I)

Both platforms use informative recommendations: (backwards)

- Consumers join platform with highest expected utility and buy.
- Firms choose which platform to join and on either set $p^* = \frac{\alpha-\sigma}{2}$.
- Platforms simultaneously maximise profits, selecting σ_I and σ_C.

Search for symmetric equilibrium.

(essentially a symmetric problem, here asymmetric equilibria fail to be stable.)

Competitor: informative recommendations (II)

Proposition

When both platforms adopt informative rec. sys., there exists a unique symmetric equilibrium:

1. $\sigma^c = 0.379 > \sigma^m$.
2. *Firms multi-home if* $\alpha \geq \sigma^c$ *and are inactive otherwise.*

Competitor: informative recommendations (II)

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- Informative competition drives informative recommendations.
- Consumer surplus increases — driven by 'new' consumers + recommendations (better firms and lower prices given quality).
- Issues with symmetric equilibrium?

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- Issues with symmetric equilibrium?
  DMA: data sharing // level playing field between platforms $\rightarrow$ competition between firms on each platform.

Fostering–Enshittification

Fostering Phase

- Monopoly (eBay): from simple lists to value rec sys.
- Consumer awareness leads to more informative rec.sys.
- Competition: rec.sys. become more informative of value.

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Enshittification Phase

- Rise of gatekeepers $\Rightarrow$ less informative of value.
- More complex recommendation mechanisms $\Rightarrow$ less informative of value. (less transparent)

Enshittification bad, but better than leaving consumers to fend for themselves.

Roadmap

More results (I): marginal cost

In the monopoly setting, suppose instead:

- Firms face a positive marginal cost e.

Firms:

- Optimal pricing strategy $\frac{\alpha-\sigma+e}{2}$.
- Only firms with $\alpha > \sigma + e$ are active — marginal costs drives screening.

More results (I): marginal cost

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Firms:

- Optimal pricing strategy $\frac{\alpha-\sigma+e}{2}$.
- Only firms with $\alpha > \sigma + e$ are active — marginal costs drives screening.

Platform:

- Firms set higher prices $\rightarrow$ platforms fee increases.
- Tradeoff between per transaction revenue and volume becomes less stark.
- Obtain volume: prefer more informative recommendations, $\sigma > \sigma^m$.

All effects serve to improve CS.

More results (II): per unit fees

In the monopoly setting, suppose instead:

- The platform sets per-unit fees, b, rather than ad-valorem fees.
- Announces its fee b alongside σ.

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In equilibrium:

- Firms optimal pricing strategy is $\frac{\alpha-\sigma+b}{2}$.
- Platform profit is increasing in σ, and they prefer $\sigma = 1 - b$ such that only the highest quality firm is active.
- Optimal $b^* = \frac{1+2\sigma}{2} = \frac{3}{4}$ and $\sigma = \frac{1}{4}$.

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- Optimal $b^* = \frac{1+2\sigma}{2} = \frac{3}{4}$ and $\sigma = \frac{1}{4}$.

Platform extracts full profits. Consumers only interact with highest quality firm and $CS = \frac{1}{4}$.

More results (III): Asymmetric competition (I)

In the competition setting, suppose instead:

- There is asymmetric consumer inertia across platforms:
  - The distribution of inertia to join competitor first order stochastic dominate the inertia to join incumbent. (more costly to join competitor.)
  - Crudely suppose: $c_{i,I} \sim U[0,1]$ and $c_{i,C} \sim$ triangular distribution peak 1.

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Proposition

There exists a unique equilibrium where $\sigma_C = 0.475 > \sigma_I = 0.319$.

Closely relates to how a new competitor (TikTok) wants to gain market share through better algorithms (against Instagram).

More results (IV): Asymmetric competition (II)

In the competition setting, suppose instead:

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- Allow the incumbent to be more 'flexible' and move second.

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- Platforms announce their recommender system sequentially.
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Firms: optimal price $p = \frac{\alpha - \sigma_k}{2}$.

- $\alpha \geq max\{\sigma_C, \sigma_I\}$ multi-home.
- $\alpha \in [\sigma_C, \sigma_I)$ single-home.
- $\alpha < min\{\sigma_C, \sigma_I\}$ inactive.

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Proposition

There exists a unique equilibrium where $\sigma_I = 0.360 > \sigma_C = 0.311$, $\Pi_I > \Pi_C$.

Even with asymmetric data, competition can stimulate informative recommendations

More results (V): Multi-homing consumers

In the competition setting, suppose instead consumers search across platforms:

- Consumers join platform giving highest $E[u_k] - c_{i,k}$.
- They see a firm, if value is too low go to next platform.

Note: search is 'costly' in that inertia is positive.

More results (V): Multi-homing consumers

In the competition setting, suppose instead consumers search across platforms:

- Consumers join platform giving highest $E[u_k] - c_{i,k}$.
- They see a firm, if value is too low go to next platform.

Note: search is 'costly' in that inertia is positive.

Proposition

There exists a symmetric equilibrium where $\sigma < \sigma^m$.

This is unique under uniform distribution.

Remark

When consumers search, competition lowers consumer surplus.

More results: Robustness

Monopoly

- General distributions: Relative informativeness of rec.sys. hold if
  - Distribution of high-quality firms not to heavy.
  - Distribution of consumer inertia not too low.
- Negative consumption utility
- General recommender function

Competition

- Costly firm entry onto second platform.
  - Top firms join both platforms; Next group join one platform at random; Last group join less informative platform.
  - The rest exit.

Roadmap

Related Literature

Closest (?) theory papers:

- Platforms competition: Damiano and Hao, 2008
- Non-price strategies: Jeon and Rochet, 2010; Nocke and Strausz, 2023; Casner and Teh, Forthcoming
- Competition among search engines: De Corniere, 2016

Related empirical evidence:

- Recommender systems build trust: Chen and He, 2011
- Value drives reputation: Luca, 2016
- Informative systems, lower prices: Jin and Kato, 2006

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- Competing rec.sys.? Please let me know.

Summary

- Capture how recommender systems evolved over time (1997 – 2024).
- Rise of Gatekeepers can explain enshittification.
- Consumers are not necessarily worse-off despite Gatekeepers
- DSA 27 seems redundant.
  Already in platforms interest to be transparent.
  Difficult for consumers to do better than platform.
- Regulating gatekeepers not only facilitate competition between platforms but between firms on platforms.

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Questions? Comments?
Thanks for the invite.
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