Market Structure and the Distribution of Content

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Motivation

- Entertainment products are ubiquitous.
  - Music, Movies, Books, etc.
- It is unclear how markets interact with defining product characteristics.
  - Both horizontal (genre) and vertical (quality) differentiation.
  - Quality is ex-ante uncertain.
  - Consumer demand is high, as is turnover.
- Digitalization has radically changed these markets.

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How have changes in market structures influenced the distribution of products?

Main Results

Quality uncertainty leads to *allocative* inefficiency: producers inefficiently sort.

Focus on three market structures:

- Competitive Equilibria
    - Inefficiently little product diversity.
- Integrated Platform (e.g., Netflix)
    - Coordinating production restores efficiency.
- Recommendation System (e.g., Spotify)
    - Can restore some efficiency by suppressing some content.

Related Literature

Entertainment Industry

- Aguiar and Waldfogel (2018), Gambato (2025)

Content Markets and Recommendation Systems

- Chen, Li, and Preuss (2025), Calvano et al. (2025)

Contests

- Drugov and Ryvkin (2020), Ryvkin and Drugov (2020), Grossmann (2021)

Model

Products and Producers

Mass m of ex-ante identical producers.

- Choose to produce in a genre $g \in G = \{1, ..., G\}$.
- After this decision, quality $v \sim F$ is realized (independently).

Assumption

Let $\overline{F}(v) = 1 - F(v)$. F has increasing hazard rates: $\frac{f(v)}{\overline{F}(v)}$ is strictly increasing.

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A strategy for producers corresponds to a mapping $\Psi : [0, m] \to \Delta G$.

- Ψ induces a genre allocation $\psi \in m \cdot \Delta G$ of producers: $\psi_g = \int_0^m \Psi_g(i) di$.
- ψ induces μ^ψ the measure of content: $\mu_g^\psi((v, \infty)) = \psi_g \cdot \overline{F}(v)$.

Consumers

There is a unit mass of consumers.

- Each consumer has a type (g, t):
  - g determines which genre he will consume.
  - t determines *how much* content he is willing to consume.
- Let T be the distribution of types.
- Let T_g be the distribution of demand for genre g, derived from T.

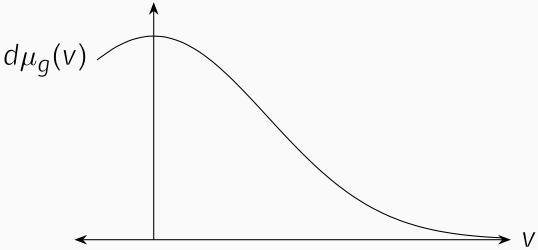
Assumption

T_g is regular, for each g: $t - \frac{\overline{T}_g(t)}{dT_g(t)}$ is increasing, and is full-support on $[0, \bar{t}_g]$.

Consumer Utility without Prices

Consumers receive utility proportional to the quality of products they consume.

- Without prices, will consume the highest-quality content available.



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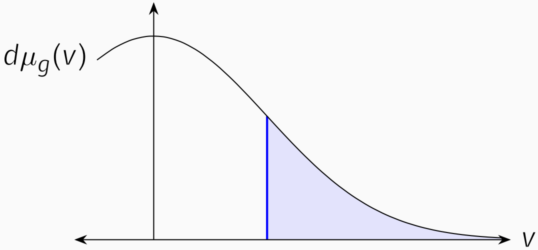

Consumer (g, t)'s utility is

$$\int_{v_g(t)}^{\infty} v \, d\mu_g(v)$$

where $v_g(t)$ is such that

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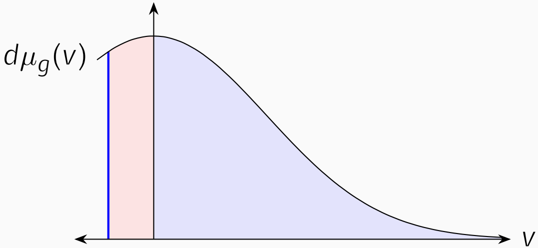

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Prices

Producers are price takers: they take the price of good, $P(v)$ as given.

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For today, focus on linear pricing functions.

Definition

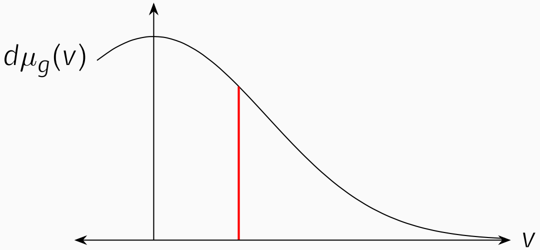
I call a pricing function P linear if $P(v) = p + \alpha(v - p)$ for $p \in \mathbb{R}_+$ and $\alpha \in [0, 1]$. Denote this function $P_{p,\alpha}$.

- p represents the base price.
- α represents the additional amount that producers can differentiate price based on quality.

Consumer Utility with Prices

If the price of each good is $P_{p,\alpha}(v) \neq 0$, consumers will not consume to 0.

- Since $v - P_{p,\alpha}(v)$ is increasing, will still consume the highest quality goods.



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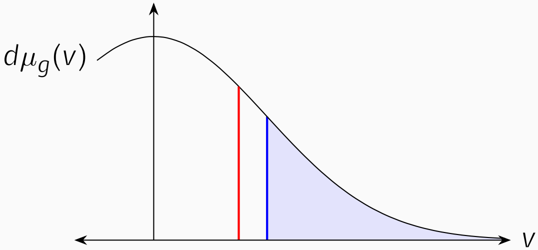

Consumer (g, t)'s utility is

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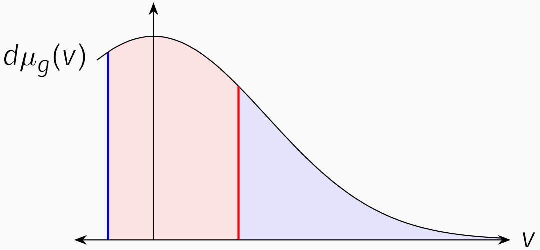

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$$\mu_g([v_g(t), \infty)) = t$$

Producer Profits

Given consumer demand thresholds $\{v_g(t)\}_{(g,t)}$, expected profits from genre g:

$$\int_p^\infty \underbrace{\int_{v_g^{-1}(v)}^\infty P(v)\,dT_g(t)}_{\text{Profit from realization } v} f(v)dv = \int_0^\infty \underbrace{\int_{\max\{p, v_g(t)\}}^\infty P(v)f(v)dv}_{\text{Profit from consumer } (g,t)} dT_g(t)$$

Timing

- Producers choose genres to maximize expected profits
    - These choices induce $\psi \in m \cdot \Delta G$.
- Producer qualities are realized.
- Consumers choose bundles.
- Consumer utility and Producer profits are realized.

Competitive Equilibrium

Producer Profits

Fix an allocation of producers $\psi \in m \cdot \Delta G$ and (p, α).

For a consumer (g, t), face content μ_g^ψ.

- Threshold $v_g(t)$ will solve $t = \psi_g \overline{F}(v)$.

Hence, will consume everything above $\max\left\{p, \overline{F}^{-1}\left(\frac{t}{\psi_g}\right)\right\}$.

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Facing competition ψ, expected profits in genre g are given by

$$\int_0^\infty \Pi_{p,\alpha} \left(\min \left\{ \overline{F}(p), \frac{t}{\psi_g} \right\} \right) dT_g(t), \quad \text{where} \quad \Pi_{p,\alpha}(x) := \int_{\overline{F}^{-1}(x)}^\infty P_{p,\alpha}(v) f(v) dv$$

For $(p, \alpha) = (0, 0)$, let $\Pi_{0,0}(x) := \int_{\overline{F}^{-1}(x)}^\infty f(v) dv$.

Competitive Equilibrium

Definition

A competitive equilibrium $\psi^{p,\alpha}$ for pricing function $P_{p,\alpha}(v)$ is an allocation of producers such that

$$\psi_g > 0 \iff g \in \operatorname*{argmax}_{g \in G} \int_0^\infty \Pi_{p,\alpha}\left(\min\left\{\bar{F}(p), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

Lemma

$\psi^{p,\alpha}$ is unique for each (p, α).

Let $A^{p,\alpha} := \left\{g \,|\, \psi_g^{p,\alpha} > 0\right\}$ denote the set of "active" genres.

The Integrated Platform

Integrated Platform: Setup

Consider a platform which controls production and sells to consumers.

- It doesn’t charge per good, but is able to bundle.
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- This allows the platform can extract full surplus from consumers.

At an allocation of producers ψ, a consumer (g, t)'s utility from consumption is

$$\psi_g W\left(\min\left\{\overline{F}(0), \frac{t}{\psi_g}\right\}\right)$$

where

$$W(x) \coloneqq \int_{\overline{F}^{-1}(x)}^{\infty} v f(v) dv$$

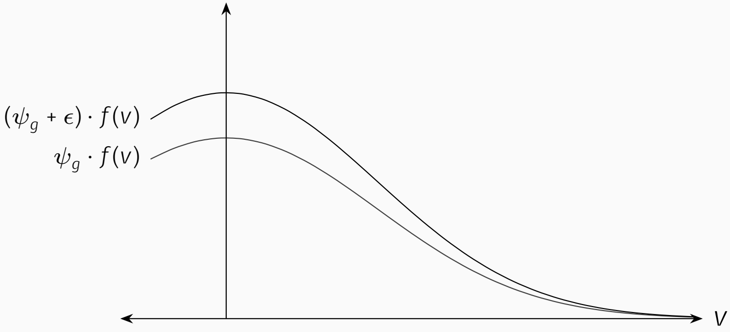
The Platform's Problem

Definition

An integrated optimal ψ^I is an allocation of producers such that

$$\psi^I \in \underset{\psi \in m\Delta G}{\operatorname{argmax}} \sum_{g \in G} \psi_g \cdot \int_0^\infty W\left(\min\left\{\overline{F}(0), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

Solving the Platform's Problem



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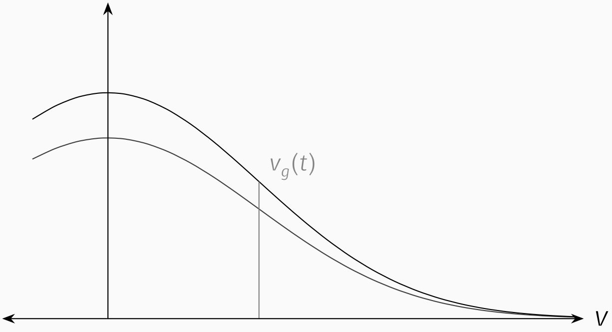

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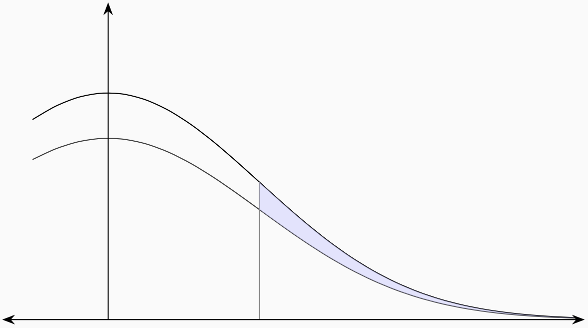

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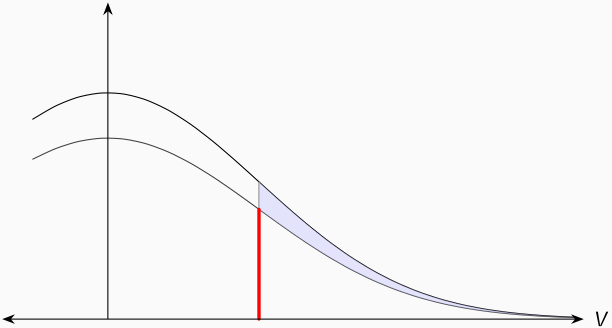

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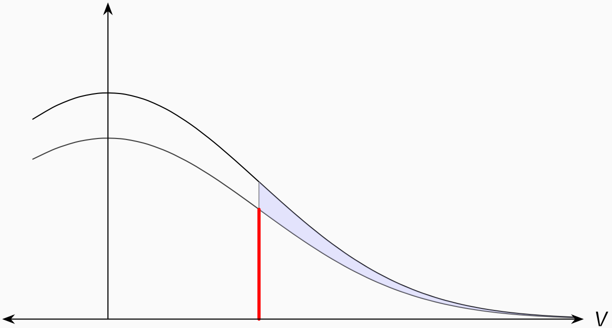

Consider the benefit from increasing ψ_g:

$$M(x) := \int_{\overline{F}^{-1}(x)}^{\infty} \left(v - \overline{F}^{-1}(x)\right) f(v)\,dv$$

Integrated Optimality

The platform hence sets

$$\int_0^\infty M\left(\min\left\{\overline{F}(0), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

equal across all active g.

Lemma

The integrated optimal ψ^I is the unique allocation such that

$$\psi_g > 0 \iff g \in \underset{g \in G}{\operatorname{argmax}} \int_0^\infty M\left(\min\left\{\overline{F}(0), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

Let $A^I \coloneqq \{g | \psi_g^I > 0\}$. This is the set of "active" genres.

Market Failures and Quality Uncertainty

Two Possible Market Failures

"Posted-Price Problem":

- In the competitive equilibrium, the base price p means that low-value goods are not consumed.
- By offering a menu of bundles, the platform is able to overcome this problem.

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Allocative Inefficiencies:

- How producers sort into different genres depends on the market structure.
- This sorting also depends crucially on the timing of quality realization.

Ex-ante Quality Realization

An alternative is a setting where uncertainty is resolved before genre decisions.

If producers know their quality they perfectly anticipate demand.

- The highest quality producers will claim the highest demand.

Definition

- Let $\mu^{p,\alpha}$ be the distribution of quality under the competitive equilibrium.
- Let μ^{I} be the distribution of quality under the integrated platform.

They are both unique for producers with positive demand ($v \geq p$ or $v > 0$).

Quality uncertainty is necessary and sufficient for allocative inefficiency

Theorem

Fix any (p, α).

(i) If quality is realized ex-ante, then there is no allocative inefficiency above the base price: $\mu_g^{p,\alpha}(B) = \mu_g^I(B)$ for all $g \in G$ and $B \subseteq (p, \infty)$.

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(ii) If quality is realized ex-post, and the platform's allocation is non-degenerate ($|A^I| > 1$), then there is generically allocative inefficiency: $\psi^{p,\alpha} \neq \psi^I$.

Genericity is with respect to T, and is required because of edge-cases (e.g., if T_g is equal for all g).

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This allocative inefficiency is driven by the risk facing producers being different from the risk facing the platform.

The Form of the Failure

Product Diversity

Recall that A^S is the set of active genres in market structure S: $A^S := \{g : \psi_g^S > 0\}$.

Definition

Given two market structures, S, S', I say that S features *less range* than S' if $A^S \subseteq A^{S'}$.

Product range is a coarse measure of concentration: how many genres are produced in a market structure.

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(i) Range decreases in price differentiation: $A^{p,\alpha}$ is shrinking in α;

(ii) Range decreases in base price: $A^{p,0}$ is shrinking in p;

(iii) All competitive equilibria have less range than the platform's optimal allocation: $A^{p,\alpha} \subseteq A^I$.

Proof idea

Lemma

(i) For all (p, α), $\Pi_{p,\alpha}$ is strictly increasing and concave. If $\alpha = 0$, $\Pi_{p,0}$ is linear.

(ii) M is strictly increasing and strictly convex. (Due to increasing hazard rates.)

This implies that

- Price differentiation causes producers to weight low-demand consumers.
- The platform places low weight on low-demand consumers.
- When a genre is inactive, all consumers are effectively high-demand.

Recommendation System

Recommendation Systems

Many platforms are not integrated; they do not directly control production.

- Their influence over producers comes from through recommendations to consumers.

These recommendation systems trade-off between

- Using recommendations to motivate producers; and
- Recommending the best content to consumers.

Recommendation Mechanism

A mechanism is a set of possible "sub-genres" for producers. Sub-genres are

- A genre, specifying the type of content; and
- A recommendation function.

Producers still care about maximizing demand, and sort into sub-genres accordingly.

- Influencing producers requires suppressing content.

Formal Definition

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- Influencing producers requires suppressing content.

If the platform cannot commit, it implements the (0,0) competitive equilibrium.

Formal Definition

Simplifying the Problem

The space of mechanisms is large, but optimal mechanisms are simple:

Lemma

An optimal mechanism is $p \in \mathbb{R}_+^G$ and ψ that maximize

$$\sum_{g \in G} \psi_g \cdot \int_0^\infty W\left(\min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

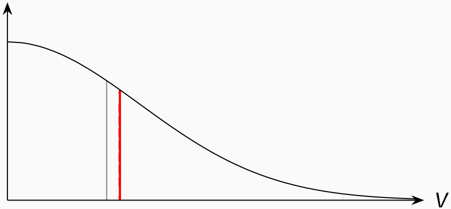
$$\text{s.t.} \quad \psi_g > 0 \iff g \in \operatorname*{argmax}_{g \in G} \int_0^\infty \min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\} dT_g(t)$$

Let ψ^R denote an optimal allocation.

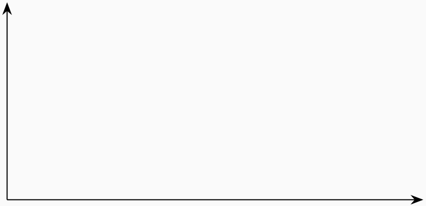
Formal Derivation

Intuition: How can a mechanism help?

Consider a setting where $A^{0,0} = \{1\}, A^{I} = \{1, 2\}$.



Genre 1



Genre 2

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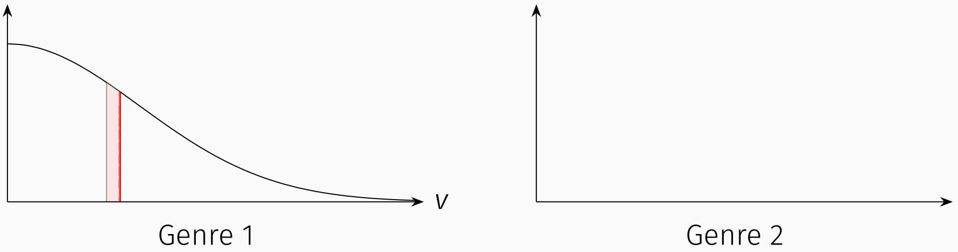

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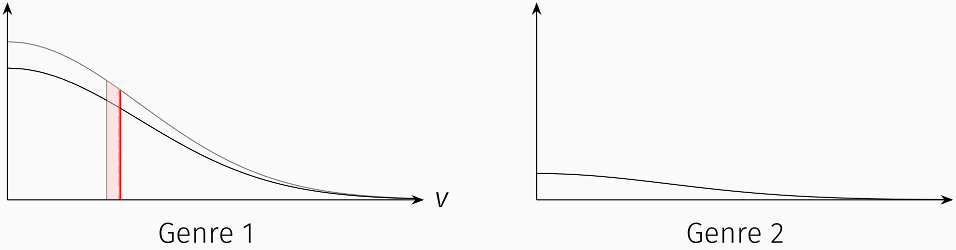

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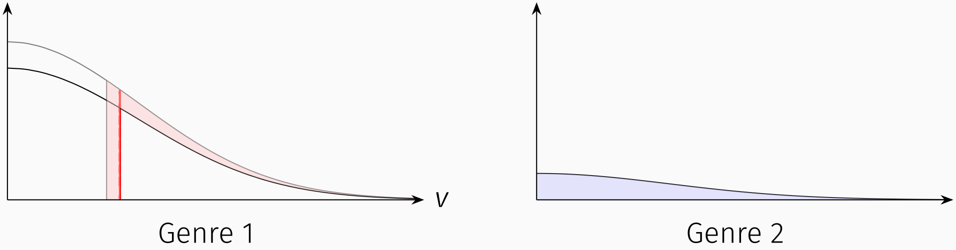


Properties of the Optimal Mechanism.

Theorem

Fix an optimal mechanism and the corresponding active set A^R.

(i) It is possible for the optimal mechanism to improve on the $(0, 0)$ competitive equilibrium;

(ii) $A^{0,0} \subseteq A^R$; and

(iii) $A^R \subseteq A^I$.

Both inclusions in (ii) and (iii) may be strict.

Comparative Statics

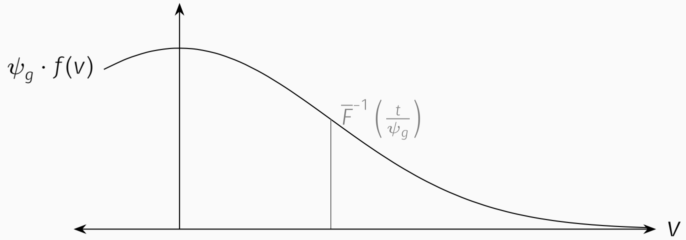
Consumer Heterogeneity

Proposition

Consider two genres g, g' with $T_{g'}$ a mean-preserving spread of T_g.

(i) $\psi_g^{p,\alpha} \geq \psi_{g'}^{p,\alpha}$, for all p, α.

(ii) There exists an $\overline{m}$ such that, for all $m \leq \overline{m}$, $\psi_g^l \geq \psi_{g'}^l$ and for all $m > \overline{m}$, $\psi_g^l \leq \psi_{g'}^l$.



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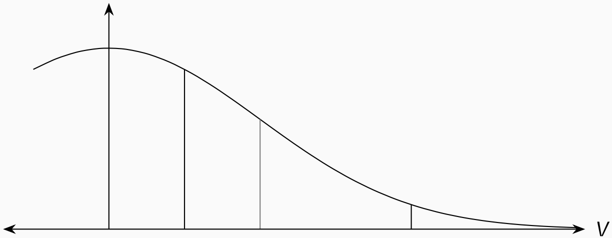

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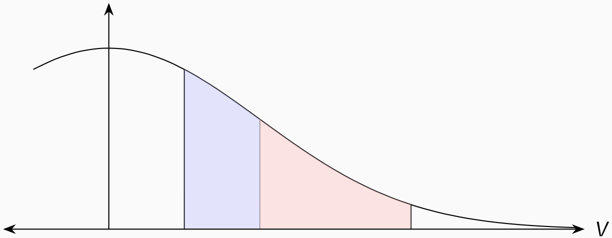

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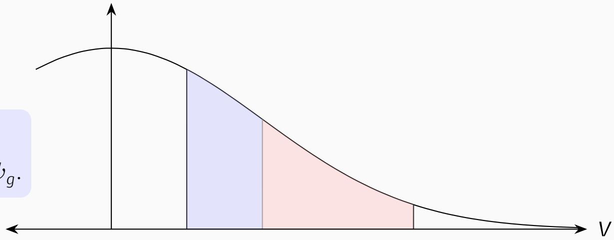
Concavity of $\Pi_{p,\alpha}$ $\Rightarrow$

Producers respond by decreasing ψ_g.

Convexity of M $\Rightarrow$

The platform responds by increasing ψ_g.



Fatter tails lead to less range

Tightening the distribution encourages a wider distribution of content.

Proposition

Fix a transformation $v \mapsto \tau(v)$ where τ is increasing with $\tau(0) = 0$. This induces distribution $\hat{F}(v) = F(\tau^{-1}(v))$.

(i) If τ is concave, then $A^l \subseteq A^l_\tau$.

(ii) If τ is convex, then $A^l \supseteq A^l_\tau$.

(iii) $A^{0,0} = A^{0,0}_\tau$.

Possible Directions and Conclusion

Heterogeneity in F and Decreasing hazard rates

Introducing heterogeneity in F can create large disagreement between the competitive equilibrium and the socially optimal allocation.

- If pricing is uniform, firms are not sensitive to the differences in quality distributions. This leads them to over-invest in genres with “bad” distributions, but high demand.

Decreasing Hazard Rates

- If F has *decreasing* hazard rates (very fat tails), there is too *much* product diversity in flat-price competitive equilibria.
- Corresponds to intuition from the contest literature.

Other possible directions

Subscription pricing.

- Preliminary results: Genre-specific subscription pricing leads to too much product diversity.
- Would also be interesting to study the effect of bundling in these markets.

More general framework of concurrent contests.

- Effect of prize structures on endogenous sorting across contests.
- Also, producer effort and entry.

Conclusion

I build a model highlighting how ex-ante uncertainty over product quality leads to market inefficiencies.

- In particular, I show that it leads to excessive concentration.
- Introducing an integrated platform restores efficiency.
- Recommendation Systems are able to restore some efficiency, at the cost of suppressing some content.

Set of mechanisms

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Definition

A mechanism is a set of sub-genres $\mathcal{S}$ and an allocation $\tilde{\psi} \in m\Delta\mathcal{S}$ such that

$$\sum_{g \in G} \int_0^\infty \left(\int_{\max\{v_g(t),0\}}^\infty v d\mu_{g,t}(v) \right) dT_g(t)$$

such that

$$d\mu_{g,t}(v) = \sum_{s=(g,r_s)} \tilde{\psi}_s r_s(v,t) f(v)$$

$$t = \mu_{g,t}([v_g(t), \infty))$$

$$\tilde{\psi}_s > 0 \iff s \in \underset{s \in \mathcal{S}}{\operatorname{argmax}} \int_0^\infty \left(\int_{\max\{0,v_g(t)\}}^\infty r_s(v,t) f(v) dv \right) dT_g(t)$$

Recommendation System's Problem

$$\max_{p_g,\psi_g,s_g,\overline{Q}} \sum_{x\in X} \psi_g \int W\left(\min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\}\right) dT_g(t)$$

subject to the following constraints:

$$s_g + \int \min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\} dT_g(t) - \overline{Q} = 0,$$

$$\psi_g s_g = 0,$$

$$m - \sum_{x\in G} \psi_g = 0,$$

$$\psi_g \geq 0, \quad s_g \geq 0, \quad p_g \geq 0$$

Lemma

If a set of penalties p_g and producer allocations ψ_g are optimal, then there exist $\overline{Q}$ and η such that for all g with $\psi_g > 0$:

$$\int \min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\} dT_g(t) = \overline{Q}$$

$$\int M\left(\min\left\{\overline{F}(p_g), \frac{t}{\psi_g}\right\}\right) dT_g(t) + \overline{Q} \cdot p_g = \eta \qquad \text{if} \quad p_g > 0$$

$$\int M\left(\min\left\{\overline{F}(0), \frac{t}{\psi_g}\right\}\right) dT_g(t) \geq \eta \qquad \text{if} \quad p_g = 0$$

$$\min p_g = 0$$

$$\sum \psi_g = m$$

If $\psi_g = 0$, it is without loss to set $p_g = \infty$.