Search, Design, and Market Structure

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The effect of the Internet

- Lower search costs were expected to lead to harsher competition and lower profits?
- Effect on sales
  - **Long tail:** Anderson (2004,6), Brynjolfsson, Hu and Smith (2006)
  - **Superstars:** Elberse and Oberholzer-Gee (2006), Goldmanis, Hortacsu, Onsel and Syversson (2009)
Costly Search and Design

- Ceteris paribus, lower search costs lead to lower prices
- Model introduces firm design choices
  - marketing/information
  - type of product ranging from broad (lowest common denominator) to niche (very specialized)
- Search costs affect pricing but also product variety
Niche and Broad Designs

broad design

niche design
Results

- Characterization of Equilibrium
  - Prevalence and coexistence of very different design strategies
  - “Low-type” firms specialize, “high-type” firms go mass-market

- Comparative Statics: Lower search costs lead to more niche firms, softening price competition and leading consumers to shop around
  - Profits and prices can be non-monotonic in search costs
  - Model delivers coexistence of long-tail and superstar effects
Anecdotal Support

“Both the hits and the tail are doing well,” says Jeff Bewkes, the head of Time Warner, an American media giant. Audiences are at once fragmenting into niches and consolidating around blockbusters. Of course, media consumption has not risen much over the years, so something must be losing out. That something is the almost but not quite popular content that occupies the middle ground between blockbusters and niches. The stuff that people used to watch or listen to largely because there was little else on is increasingly being ignored. The Economist, November 24, 2009
Model

- Continuum of firms of measure 1, endowed with a production technology $v \sim H(\cdot)$ on $V$.
- Continuum of consumers of measure $m$.
- Consumer $l$ when consuming good from firm $i$ at price $p_i$ gains utility (not including any search costs)
  \[ u_{li}(p_i) = v_i + \varepsilon_{li} - p_i \]
  where $\varepsilon_{li} \sim F_s(.)$ is the value of the firm-consumer specific match and is i.i.d. across $l$ and $i$.
- The cost of visiting an additional firm is $c > 0$
- If consumer $l$ buys product $i$ at price $p_i$ after visiting $k$ firms she gets
  \[ u_{li}(p_i) - kc, \]
Firm Strategy

- A firm’s strategy: Each \( v \) chooses a price \( p \) and a design \( s \in [B, N] \)
  - \( \sigma : V \rightarrow \Delta(\mathbb{R} \times [B, N]) \)
- Design *a la* Johnson and Myatt (2006):
  - \( F_s(.) \) has support on some interval \( (\theta_s, \bar{\theta}_s) \) is continuously differentiable and the distribution has logconcave densities \( f_s(\theta) \)
  - \( \forall s \exists \) a rotation point \( \theta^*_s \) such that \( \frac{\partial F_s(\theta)}{\partial s} < 0 \) for \( \theta > \theta^*_s \) and \( \frac{\partial F_s(\theta)}{\partial s} > 0 \) for \( \theta < \theta^*_s \); further \( \theta^*_s \) is increasing in \( s \)
  - interpretation as physical design or information (then restrict to mean-preserving spread)
Demand Rotations

single rotation point

 differing rotation points
Consumer Strategy

- Consumer strategy: choose whether or not to continue search, choose whether or not to buy
  - Note that with a continuum firms, irrelevant whether or not consumers hold onto previous offers
- Restrict to an optimal stopping rule: a consumer continues searching until he finds an offer such that $v - p + \varepsilon \geq U$
Proposition

Firms choose extremal designs, that is every firm chooses either the most niche \((s = N)\) or most broad \((s = B)\) design.
optimal price is above the point of rotation: more "nichey" design

optimal price is below the point of rotation: more "broad" design
Equilibrium consists of \((U, V, p_v)\) satisfying:

- Consumer optimal stopping rule
- Firm optimal design choice, where all \(v < V\) go niche, and \(v > V\) broad
- Price is optimal for each design
- Participation constraint for consumer
- There is always a class of boring equilibria, firms charging high prices and design irrelevant
Restrict attention to stable equilibrium (where best responses of consumer and firm behaviour bring the economy back to equilibrium).

**Proposition**

At any stable equilibrium (that is where $\frac{\partial U}{\partial V}(\cdot) < 1$) decreasing $c$ raises consumer surplus (higher $U$) and makes the fraction of niche firms (weakly) greater (higher $V$).

In an equilibrium where all firms choose broad designs or all firms choose niche designs then lower search costs reduce profits and prices.
Superstars and Longtails

Definition
We say that a *superstar effect* is present if the firm with the highest sales captures an increasing market share as search costs fall.

Definition
We say that a *long tail effect* is present if the firm with the lowest sales captures an increasing market share as search costs fall.
Superstars, Longtails and Design

**Proposition**

*Suppose that all firms choose the same design $s$, and the distribution of consumer valuations $F_s(\cdot)$ is not too concave; the superstar effect arises, but the long-tail effect does not.*

- long tail effect not solely a consequence of a fall in the cost of search, holding all else constant.
Uniformly Distributed Firms and Linear Demands

- Niche and Broad demand curves are linear
  - $\epsilon_N \sim U[\theta_N, \bar{\theta}_N]$.
  - $\epsilon_B \sim U[\theta_B, \bar{\theta}_B]$.
- Uniformly distributed firm types $\nu \sim U[L, H]$. 
Comparative Statics

Proposition

Under the assumptions above, when all firms are active then

1. There is a unique equilibrium \((U, V)\) for each search cost \(c\). When different firms choose different design strategies then as the search cost decreases

2. Consumer surplus \((U)\) increases

3. There are more niche firms \((V\) increases);

4. Profits of the highest and lowest quality firms increase if and only if \(\bar{\theta}_N - \bar{\theta}_B > H - L\);

5. The superstar effect arises; and,

6. The long tail effect can, but need not, arise; a sufficient condition for the long tail effect to arise is \(\bar{\theta}_N - \bar{\theta}_B > H - L\).

Note “more” vertical against horizontal differentiation
Example

- Linear demands
  - niche distribution uniform on $[-12, 4]$
  - broad distribution uniform on $[-3, 3]$
- Types uniformly distributed on $[0, 0.75]$
Prices against search costs

For a given firm at $\nu = 0.5$
Profits against search costs
Sales against quality

Sales against quality \((v)\) at two different search costs \((c = 0.05\) and \(c = 0.06)\).

- long tail effect
- superstar effect
Related Literature

- Search models (design exogenous)

- Product design and demand rotations (monopoly models)
  - Johnson and Myatt (2006); Lewis and Sappington (1994); Bar-Isaac, Caruana and Cuñat (2009)

- Search and product design / Endogenous differentiation
  - Larson (2008); Kuksov (2004); Cachon, Tewiesch and Xu (forthcoming); Watson (2007)

- Long tail and superstar effects
Conclusions

- Simple and tractable model that integrates consumer search and firms’ strategic price and product design choices.
- Search costs affect product design
- Prevalence and coexistence of very different design strategies, with rich price and sale distributions
- Firms with better technologies will tend to adopt broader strategies
- Prices and profits may be non-monotonic in search costs
- Long tail and superstar effects
As it becomes easier for consumers to find quirky stuff that they will love, more firms will provide such quirky stuff. This has equilibrium effects on profits and sales distributions.
Homogeneous Firms

(Degenerate distribution of $v$’s: $v = 0$ for all firms)

- Three possibilities:
  - All firms choose a broad design
  - All firms choose a niche design
  - All indifferent: a proportion $\lambda$ go niche, $(1 - \lambda)$ go broad

- An equilibrium can be summarized as a pair $(U, \lambda)$
All-Broad and all-niche Equilibria

- In all-broad region ($\lambda = 0$ and $U \leq U_B$) and all-niche region ($\lambda = 1$ and $U \geq U_N$) comparative stats as before
- Two possibilities:

![Diagram showing equilibria between all-broad and all-niche regions](image-url)
Mixed Strategy Equilibrium

- **Firm condition:**
  \[ p_B(\bar{U})(1 - F_B(p_B(\bar{U}) + \bar{U})) = p_N(\bar{U})(1 - F_N(p_N(\bar{U}) + \bar{U})) \]

- **Consumer’s condition:**
  \[ c = (1 - \lambda)c_B + \lambda c_N \]

- \( p_N(\bar{U}) > p_B(\bar{U}) \)
- **Sales:** \[ \frac{m}{\rho} (1 - F_B(p_B(\bar{U}) + \bar{U})) > \frac{m}{\rho} (1 - F_N(p_N(\bar{U}) + \bar{U})) \]
- **Consumer surplus is constant** \( \bar{U} \)
Multiplicity and Uniqueness

- \( c_B > c_N \) unique (stable) equilibria throughout
- \( c_B < c_N \) multiplicity and mixed equilib is unstable
- when demands are linear (or equivalently \( f_s(\cdot) \) is uniform) then the ratio of consumer surplus to firm profits for a monopolist is constant at \( \frac{1}{2} \)
  - when two firms facing linear demands (regardless of their slopes) who earn the same profits must generate the same consumer surplus.
  - So \( c_N = c_B \) in this case
- easy to find cases where either uniqueness (and stability) or multiplicity (and instability) can arise.
  - if demand is convex then the ratio of consumer surplus to profits is always higher than it would be in the linear case.
  - if \( F_B \) is linear and \( F_N \) is concave then \( c_N > c_B \) and multiplicity arises whereas in the opposite case,
  - if \( F_B \) concave and \( F_N \) linear then \( c_B > c_N \).
Comparative Statics Summary

Proposition

As search costs fall within the region, \( c \in (c_N, c_B) \), where both designs are offered

1. **Consumer surplus** (\( U \)) is constant;
2. **There are more niche firms** (\( \lambda \) increases);
3. **Consumers search more** (\( \rho \) decreases);
4. **Every firm’s profits increase**; and
5. **Both long tail and superstar effects arise.**
Comparative Statics: Mixed Region

- $\bar{U}$ constant throughout mixed region
- Price of niche (broad) firm does not change $p_N(\bar{U})$ (or $p_B(\bar{U})$) through mixed region
- Probability of selling to a visiting consumer does not change for niche (broad) firm: it is $1 - F_N(p_N(\bar{U}) + \bar{U})$ (or $1 - F_B(p_B(\bar{U}) + \bar{U})$) throughout mixed region
- BUT number of customers who visit changes:
  - Mix of firms and so also $\rho$ (ex-ante expected probability of buying from a random firm) changes, in particular $\rho$ decreases as $c$ falls
  - $c$ falls then more niche firms, more consumers end up going on for second, third, fourth visits etc ...
Total sales stay constant (by set up of model) but

- sales for niche firm is $\frac{m}{\rho} \left[ 1 - F_N(p_N(U) + U) \right]$ which increases as $\rho$ falls (as $c$ falls)
- sales for broad firm is $\frac{m}{\rho} \left[ 1 - F_B(p_B(U) + U) \right]$ which increases as $\rho$ falls (as $c$ falls)
- some broad switching to niche compensates for the fact that BOTH niche and broad types sells more

- mix of firms and $\rho$ change so average (sales weighted) prices/profits change
Price and profit (for a given firm) non-monotonic in search costs

Average/Total industry profits and prices also non-monotonic
Comparative Statics: Sales distributions at different search costs

- long-tail effects (niche firms have higher sales)
- superstar effects (broad firms have higher sales)
- coexistence of “superstar” and “long tail” effects